5. GENERAL SITE CHARACTERISTICS

Section 5 describes general site characteristics including physical characteristics, climate, flora and fauna, demography, cultural resources, and conceptual site models.

5.1 Physical Characteristics

The Snake River Plain (SRP) is the largest continuous physiographic feature in southern Idaho. This large topographic depression extends from the Oregon border across southern Idaho to Yellowstone National Park and northwestern Wyoming.

The SRP slopes upward from an elevation of about 750 m (2,500 ft) at the Oregon border to more than 1,500 m (5,000 ft) at Ashton northeast of the INEEL. The SRP is composed of two structurally dissimilar segments, with the division occurring between the towns of Bliss and Twin Falls, Idaho. West of Twin Falls, the Snake River has cut a valley through tertiary basin fill sediments and interbedded volcanic rocks. The stream drainage is well developed, except in a few areas covered by recent thin basalt flows. East of Bliss, Idaho, the complexion of the plain changes as the Snake River locally carves a vertical-walled canyon through thick sequences of quaternary basalt with few interbedded sedimentary deposits.

The INEEL is located on the northern edge of the eastern SRP, a northeastern-trending basin, 80 to 110 km (50 to 70 mi) wide, extending from the vicinity of Bliss on the southwest to the Yellowstone Plateau on the northeast. Three mountain ranges end at the northern and northwestern boundaries of the INEEL: the Lost River Range, the Lemhi Range, and the Beaverhead Mountains of the Bitterroot Range (see Figure 1). Between the ranges and the relatively flat plain is a relief of 1,207 to 1,408 m (3,960 to 4,620 ft) (Hull 1989). Saddle Mountain, near the southern end of the Lemhi Range, reaches an altitude of 3,295 m (10,810 ft) and is the highest point in the immediate INEEL area. The east and middle buttes have elevations of 2,003 and 1,949 m (6,572 and 6,394 ft), respectively.

The portion of the SRP occupied by the INEEL may be divided into three minor physiographic provinces. The first province is a central trough, often referred to as the Pioneer Basin, that extends to the northeast through the INEEL. Two flanking slopes descend to the trough, one from the mountains to the northwest and the other from a broad ridge on the plain to the southeast. The slopes on the northwestern flank of the trough are mainly alluvial fans originating from sediments of Birch Creek and the Little Lost River. Also forming these gentle slopes are basalt flows that have spread onto the plain. The land-forms on the southeast flank of the trough are formed by basalt flows, which spread from a volcanic zone that extends northeastward from Cedar Butte. The lavas that erupted along this zone built up a broad topographic swell directing the Snake River to its current course along the southern and southeastern edges of the plain. This topographic swell effectively separates the drainage of mountain ranges northwest of the INEEL from the Snake River.

The Pioneer Basin of the INEEL broadens to the northeast and joins the extensive Mud Lake Basin. The Big and Little Lost Rivers and Birch Creek drain into this basin from the mountains to the north and west. The intermittently flowing waters of the Big Lost River have formed a flood plain in this trough, consisting primarily of fine sands, silt, and clay. Streams flow to the Big Lost River and Birch Creek sinks, a system of playa depressions in the west-central portion of the INEEL, southeast of the town of Howe, Idaho. The sinks area covers several hundred acres and is flat, consisting of significant thicknesses of fluvial and lacustrine (lake) sediments.

5.2 Climate

Meteorological and climatological data for the INEEL and the surrounding region are collected and compiled from several meteorological stations operated by the National Oceanic and Atmospheric Administration field office in Idaho Falls, Idaho. Three stations are located at the INEEL.

Annual precipitation at the INEEL is light, with an annual average of 22.1 cm (8.7 in.). Therefore, the region is classified as semiarid to arid (Clawson, Start, and Ricks 1989). The rates of precipitation are highest during the months of May and June and lowest during July. Normal winter snowfall occurs from November through April, though occasional snowstorms occur in May, June, and October. Snowfall at the INEEL ranges from about 17.3 cm (6.8 in.) per year to about 151.6 cm (59.7 in.) per year, and the annual average is 70.1 cm (27.6 in.) (Clawson, Start, and Ricks 1989). The INEEL is subject to severe weather episodes throughout the year. Thunderstorms are observed mostly during the spring and summer. An average of two to three thunderstorms occurs during each of the months from June through August (EG&G 1981). Thunderstorms are often accompanied by strong gusty winds that may produce local dust storms. Precipitation from thunderstorms at the INEEL is generally light. Occasionally, however, rain resulting from a single thunderstorm on the INEEL exceeds the average monthly total precipitation (Bowman et al. 1984).

The moderating influence of the Pacific Ocean produces a climate at the INEEL that is usually warmer in the winter and cooler in summer than locations of similar latitude in the United States east of the Continental Divide. The mountain ranges north of the INEEL act as an effective barrier to the movement of most of the intensely cold winter air masses entering the United States from Canada. Occasionally, however, cold air spills over the mountains and is trapped in the plain. The INEEL then experiences below-normal temperatures usually lasting from 1 week to 10 days. The relatively dry air and infrequent low clouds permit intense solar heating of the surface during the day and rapid radiant cooling at night. These factors combine to give a large diurnal range in temperature near the ground. The average summer daytime maximum temperature is 28°C (83°F), while the average winter daytime maximum temperature is −0.6°C (31°F). Recorded temperature extremes at the INEEL vary from a low of −44°C (−47°F) in January to a high of 38°C (101°F) in July (Clawson, Start, and Ricks 1989).

The relative humidity at the INEEL ranges from a monthly average minimum of 18% during the summer months to a monthly average maximum of 55% during the winter. The relative humidity is directly related to diurnal temperature fluctuations. Relative humidity reaches a maximum just before sunrise (the time of lowest daily temperature) and a minimum in midafternoon (the time of maximum daily temperature) (Clawson, Start, and Ricks 1989).

The INEEL is in the belt of prevailing westerly winds, which are channeled within the eastern Snake River Plain to produce a west-southwest or southwest wind approximately 40% of the time. Local mountain valley features exhibit a strong influence on the wind flow under other meteorological conditions as well. The average midspring wind speed recorded at a height of 6 m (20 ft) is 9.3 mph, while the average midwinter wind speed is 5.1 mph (Irving 1993).

5.3 Flora and Fauna

Six broad vegetation categories representing nearly 20 distinct habitats have been identified on the INEEL: juniper-woodland, native grassland, shrub-steppe off lava, shrub-steppe on lava, modified, and wetlands. Though small riparian and wetland regions exist along the Big Lost River and Birch Creek, nearly 90% of the Site, including WAG 10, is covered by shrub-steppe vegetation. Big sagebrush, saltbush, rabbitbrush, and native grasses are the most common varieties.

The central part of the INEEL is a place of safety for wildlife because it is undeveloped, has restricted human access, and grazing and hunting are prohibited. Mostly undeveloped, this central tract may be the largest relatively undisturbed sagebrush steppe in the Intermountain West outside the national parklands (DOE-ID 1997). More than 270 vertebrate species including 43 mammalian, 210 avian, 11 reptilian, nine fish, and two amphibious species have been observed on the Site. During some years, hundreds of birds of prey and thousands of pronghorn antelope and sage grouse winter on the INEEL. Mule deer and elk also reside at the Site. Observed predators include bobcats, mountain lions, badgers, and coyotes. Bald eagles, classified as a threatened species, are commonly observed on or near the Site each winter. Peregrine falcons, recently removed from the federal endangered species list, also have been observed. In addition, other species that are candidates for listing as threatened or endangered by the U.S. Fish and Wildlife Service may either inhabit or migrate through the area. Candidate species that may frequent the area include ferruginous hawks, pygmy rabbits, Townsend's big-eared bats, burrowing owls, and loggerhead shrikes.

5.4 Demography

The populations potentially affected by INEEL activities include INEEL employees, ranchers who graze livestock in areas on or near the INEEL, hunters on or near the Site, residential populations in neighboring communities, and highway travelers.

Nine separate facilities at the INEEL include approximately 450 buildings and more than 2,000 other support facilities. In January 1996, the INEEL employed 8,616 contractor and government personnel. Approximately 60% of the total work force is employed at the INEEL Site and 40% is located in Idaho Falls, Idaho (DOE-ID 1997). Nearly all the facilities within WAGs 6 and 10 are on inactive status. The only employees who regularly work there are tour guides who escort visitors through the EBR-I Visitors Center from Memorial Day to Labor Day.

The INEEL Site is bordered by five counties: Bingham, Bonneville, Butte, Clark, and Jefferson. Major communities include Blackfoot and Shelley in Bingham County, Idaho Falls and Ammon in Bonneville County, Arco in Butte County, and Rigby in Jefferson County. The nearest community to the INEEL is Atomic City, located south of the Site border on U.S. Highway 26. Other population centers near the INEEL include Arco, 11 km (7 mi) west of the Site; Howe, west of the Site on U.S. Highway 22/33; and Mud Lake and Terreton on the northeast border of the Site.

5.5 Cultural Resources

Cultural resources are numerous on the INEEL and within WAGs 6 and 10 (Pace 2000). Resources that have been identified include archaeological sites, contemporary historic sites, and Native American cultural sites. Many of these resources are eligible for nomination to the National Register of Historic Places. One property, EBR-I within WAG 6, has been designated as a National Historic Landmark for its important contributions to the development of nuclear science and technology.

Over the past two decades, detailed inventories of archaeological sites have been assembled for some parts of the INEEL. Most of these survey efforts have focused on areas within and around major operating facilities and proposed future construction areas. As of January 1999, approximately 7.5% of the INEEL (17,400 ha [43,000 acres]) had been systematically surveyed and 1,884 significant archaeological localities ranging in age from 50 to 12,000 years had been identified. Inventories of contemporary historic resources important for their association with World War II, the Cold War, and U.S. nuclear science and technology have also been initiated. Reconnaissance surveys have been completed for all buildings currently under DOE-ID administration and are in progress at the NRF and ANL-W. Among the hundreds of buildings surveyed, 217 have been determined to be historically significant.

Far less is known about the nature and distribution of Native American cultural resources at the INEEL. However, ongoing consultation and cooperation under the Agreement in Principle between DOE-ID and the Shoshone-Bannock Tribes (DOE-ID 2000) has shown that many archaeological sites located on the INEEL are regarded as ancestral and important to tribal culture. Natural landforms and native plants and animals in the INEEL region are also of sacred and traditional importance.

5.6 Conceptual Site Models

The conceptual site models for OU 10-04 reflect the types of receptors that could be affected by exposures to contaminants in the area. Two human health conceptual site models are illustrated graphically in Figures 7 and 8. One model represents a hypothetical future residential scenario beginning 100 years in the future, and the other reflects current and future occupational scenarios. The models are based on land-use assumptions and the exposure assessment conducted for the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). Further discussion of INEEL land use appears in Section 6, and the exposure assessment is summarized in Section 7. The human health conceptual site models reflect the following land-use assumptions:

- The INEEL will remain under government ownership and institutional control for at least the next 100 years (i.e., until the year 2095, 100 years from the date of INEEL land-use projections [DOE-ID 1997]).

- No residential development (e.g., housing) will occur within the INEEL boundaries within the institutional control period.

- Future industrial development will most likely be concentrated in the central portion of the INEEL and within existing major facility areas, as compared to other portions of the INEEL.

The conceptual site models for the ecological risk assessment reflect the locations of contaminated media that ecological receptors may be exposed to surface sediments comprising the top 0.15 m (0.5 ft) of soil and subsurface soil. The complete ecological conceptual site model is shown pictorially in Figure 9. The two components of the model are illustrated graphically in Figures 10 and 11, and a summary of the exposure media and ingestion routes for INEEL ecological receptors is given in Table 1.

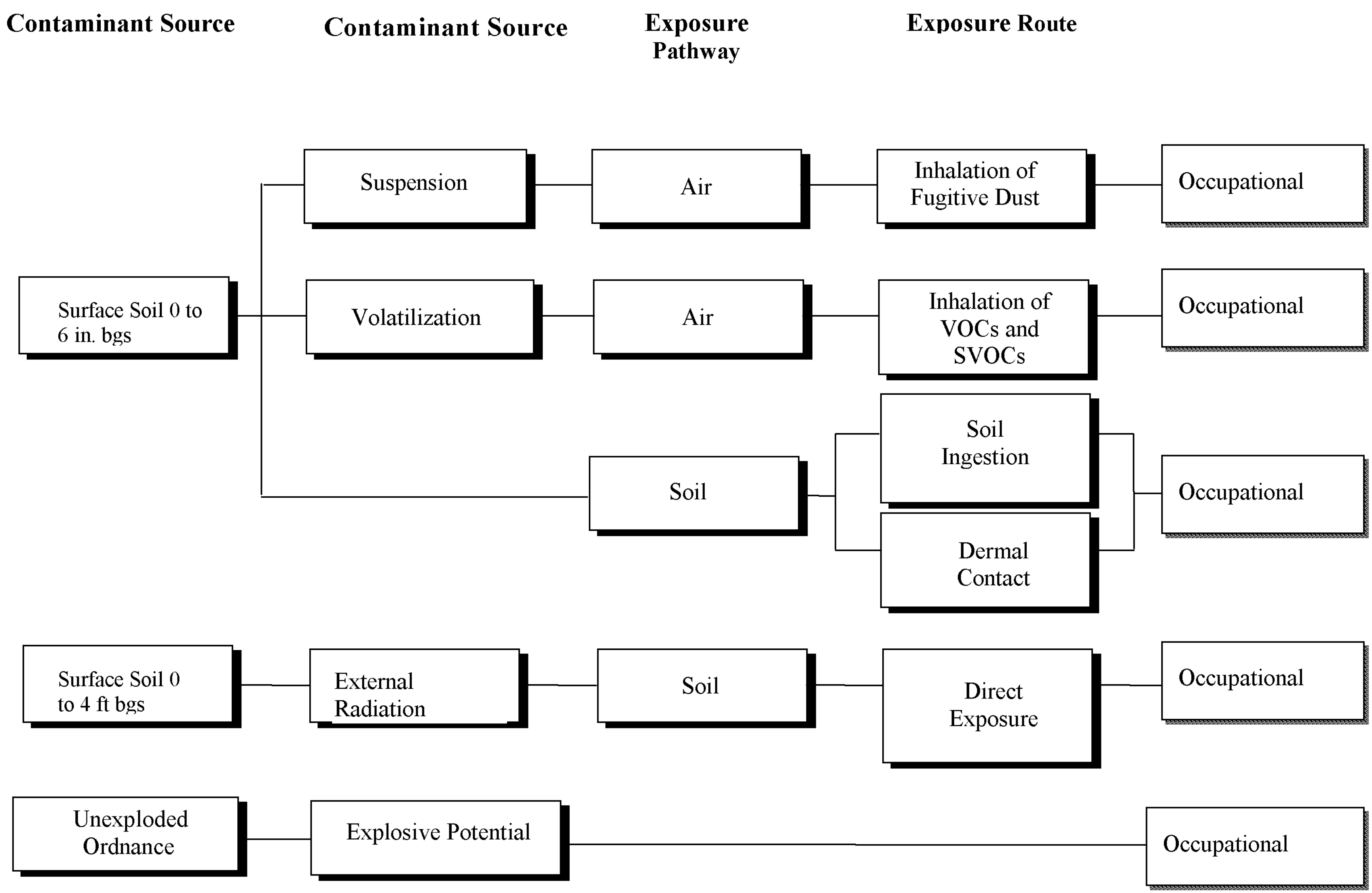

Figure 7. Human health conceptual site model for the current and future occupational exposure scenario.

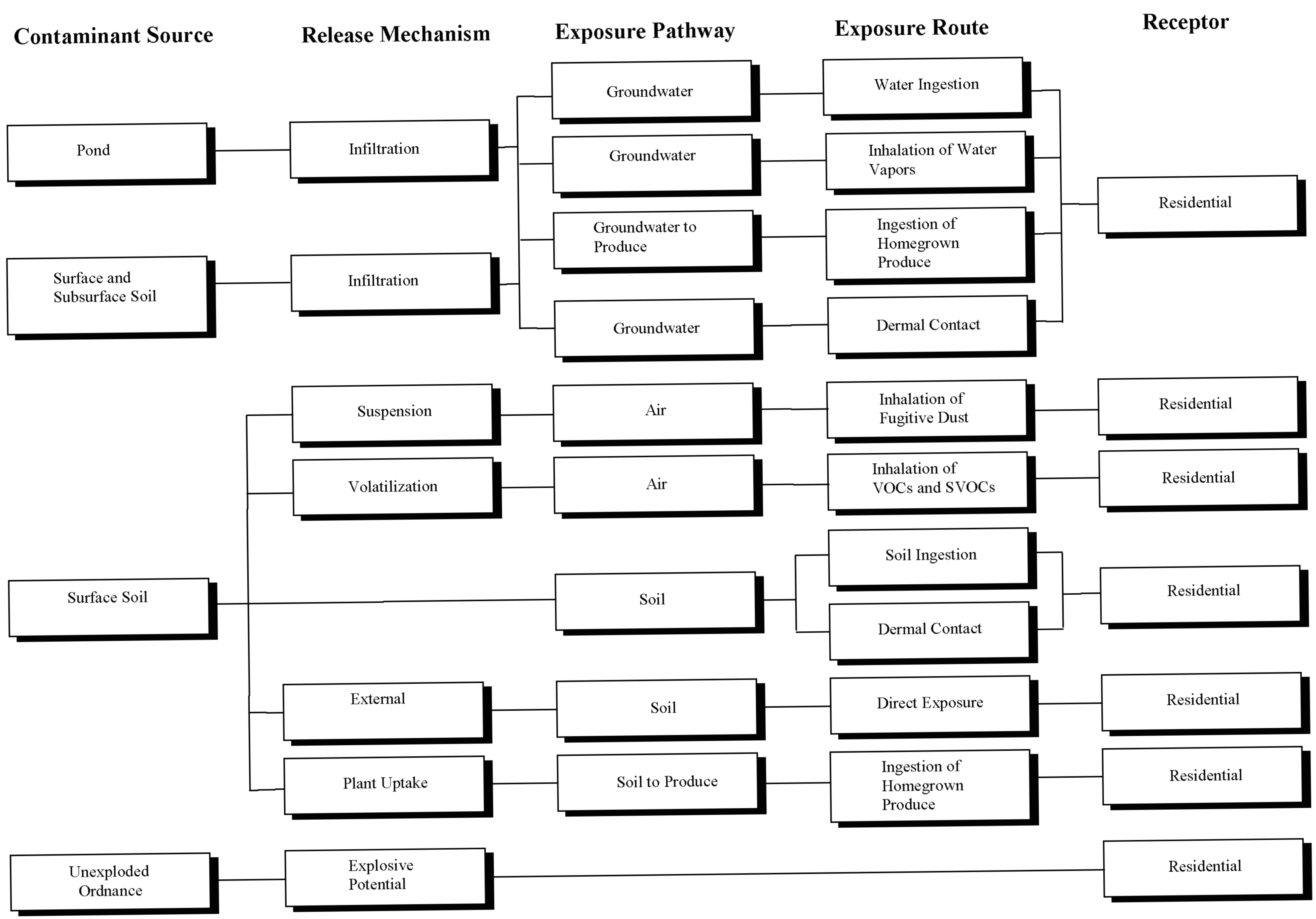

Figure 8. Human health conceptual site model for the hypothetical future residential scenario.

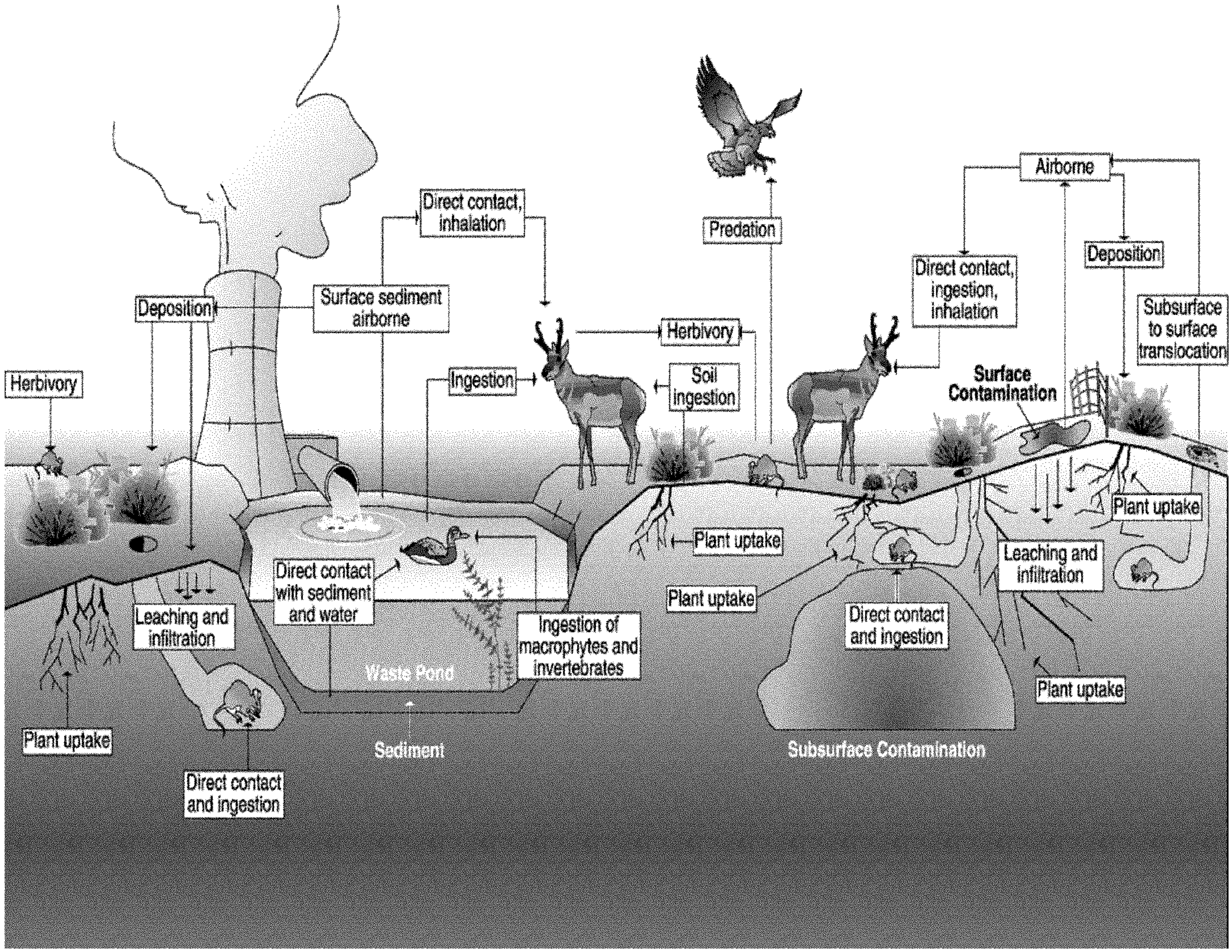

Figure 9. Ecological conceptual site model.

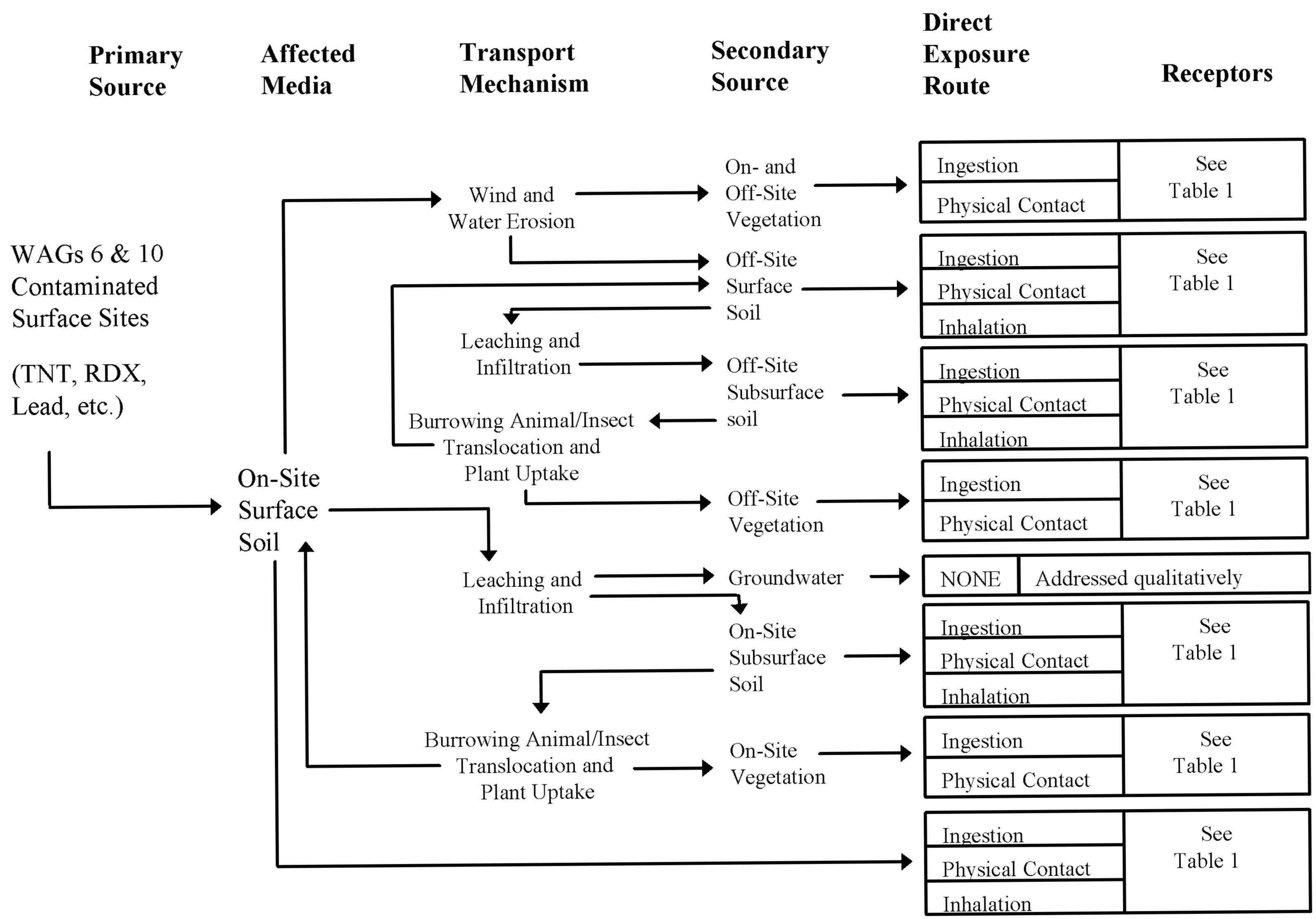

Figure 10. Model for screening level ecological risk assessment pathways and exposure for WAGs 6 and 10 surface contamination.

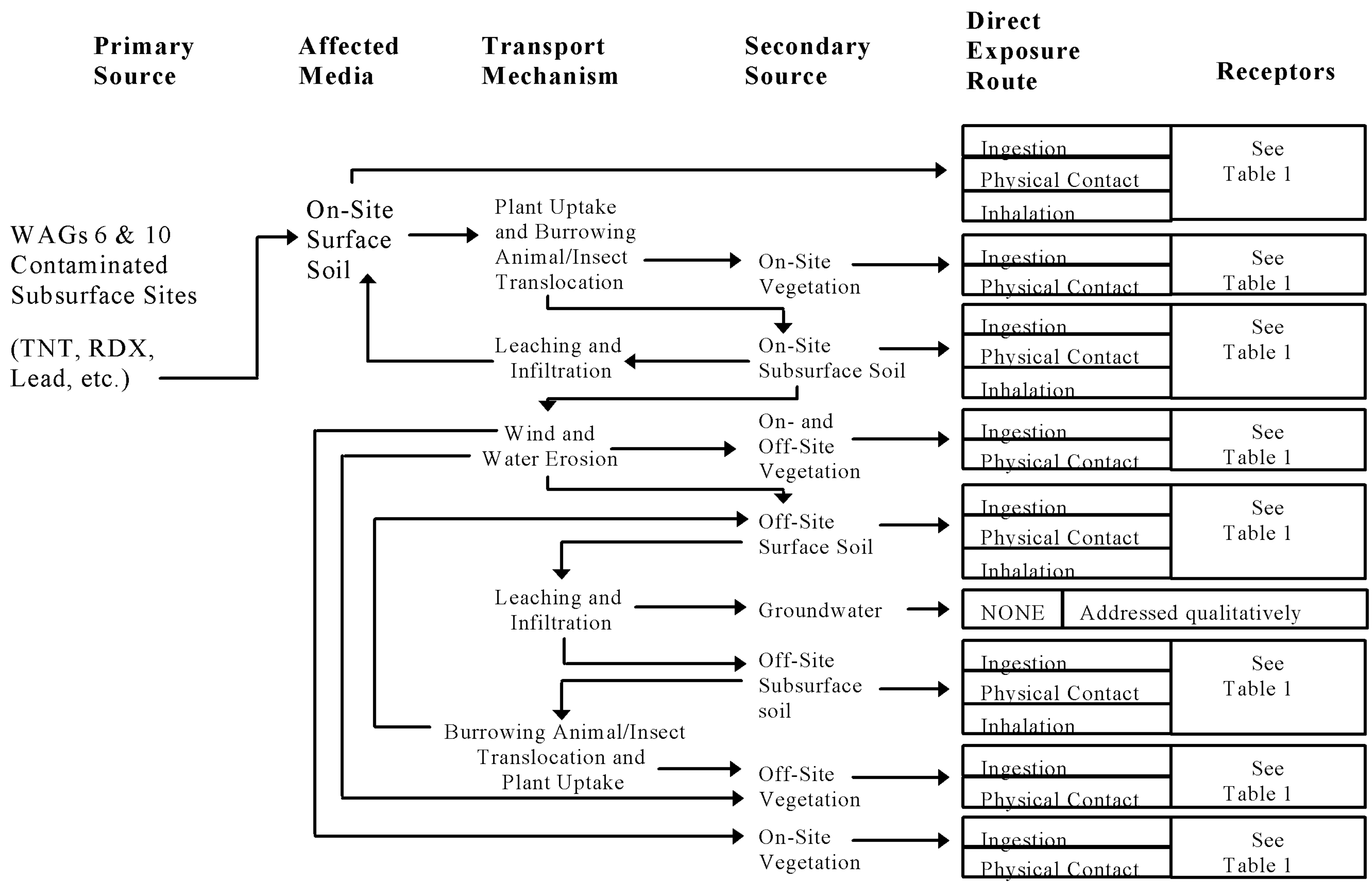

Figure 11. Model for screening level ecological risk assessment pathways and exposure for WAG 6 and 10 subsurface contamination.

Table 1. Summary of exposure media and ingestion routes for INEEL functional groups.

Receptor	Surface Soils	Subsurface Soils	Vegetation	Sediments	Prey Consumption		
					Invertebrates	Mammals	Birds
Amphibians (A232)	X	X			X		
Great Basin spadefoot toad	X	X			X		
Avian herbivores (AV122)	X						
Mourning Dove	X						
Avian (aquatic) herbivores (AV143)			X	X			
Blue-winged teal			X	X			
Avian insectivores (AV222)	X				X		
Sage sparrow	X				X		
Avian carnivores (AV322)						X	
Loggerhead shrike						X	X
Ferruginous hawk						X	
Avian carnivores (AV322A)	X	X			X	X	
Burrowing owl	X	X			X	X	
Avian omnivores (AV422)			X		X	X	X
Black-billed magpie			X		X	X	X
Mammalian herbivores (M122)	X		X				
Mule deer	X		X				
Mammalian herbivores (M122A)	X	X	X				
Pygmy rabbit	X	X	X				
Mammalian insectivores (M210A)	X				X		
Townsend's western big-eared bat	X				X		
Mammalian carnivore (M322)	X					X	
Coyote	X					X	
Mammalian omnivores (M422)	X	X	X		X		
Deer mouse	X	X	X		X		
Reptilian insectivores (R222)	X	X			X		
Sagebrush lizard	X	X			X		
Plants	X	X					

6. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The INEEL land area consists of approximately 2,305 km^2 (890 mi^2) (230,266 ha [569,000 acres]). The majority of this land, approximately 98%, has not been disturbed by Site operations. Land use on the entire INEEL is restricted, and access to the INEEL and WAG 10 is controlled. Although public highways pass through the INEEL, public access beyond the highway right-of-way is not allowed. Access to INEEL facilities requires proper clearance, training or an escort, and controls to limit exposures. Current land use and projections are summarized below.

6.1 Current Land Use

The acreage within the INEEL is classified as industrial and mixed use by the Bureau of Land Management (BLM) (DOE-ID 1997). Typical INEEL land use consists of wildlife management areas, government industrial operations areas, and waste management areas. No residential areas are contained within the INEEL boundaries. As shown in Figure 12, large tracts of land are reserved as buffer and safety zones, and operations are generally restricted to the central area. Aside from the facilities, the remaining land is largely undeveloped and is used for environmental research, ecological preservation, and sociocultural preservation. Any future construction of new facilities at the INEEL likely will occur within preferred development corridors.

The buffer consists of 1,295 km^2 (500 mi^2) of grazing land (DOE-ID 1997) administered by the Bureau of Land Management. Grazing areas at the INEEL support cattle and sheep, especially during dry conditions. Depredation hunts of game animals managed by the Idaho Department of Fish and Game are permitted on the INEEL within the buffer zone during selected years (DOE-ID 1997). Hunters are allowed access to an area that extends 0.8 km (0.5 mi) inside the INEEL boundary on portions of the Site's northeastern and western borders (DOE-ID 1997).

State Highways 22, 28, and 33 cross the Site's northeastern portion, and U.S. Highways 20 and 26 cross the southern portion (see Figure 2). One hundred forty-five km (90 mi) of paved highways used by the general public pass through the INEEL (DOE-ID 1997), and 23 km (14 mi) of Union Pacific Railroad tracks pass through the southern portion of the Site. A government-owned railroad passes from the Union Pacific Railroad through the Central Facilities Area to NRF, and a spur runs from the Union Pacific Railroad to the RWMC.

Approximately 45% of the land surrounding the INEEL is used for agriculture, 45% is open land, and 10% is urban (DOE-ID 1997). Livestock uses include sheep, cattle, hog, poultry, and dairy cattle production (Bowman et al. 1984). The major crops on land surrounding the INEEL include wheat, alfalfa, barley, potatoes, oats, and corn. Sugar beets are grown within about 40 mi of the INEEL near Rockford, Idaho, southeast of the INEEL in central Bingham County (Idaho 1996). Most of the land surrounding the INEEL is owned by private individuals or the U.S. government. The BLM administers the government land on the INEEL (DOE-ID 1997).

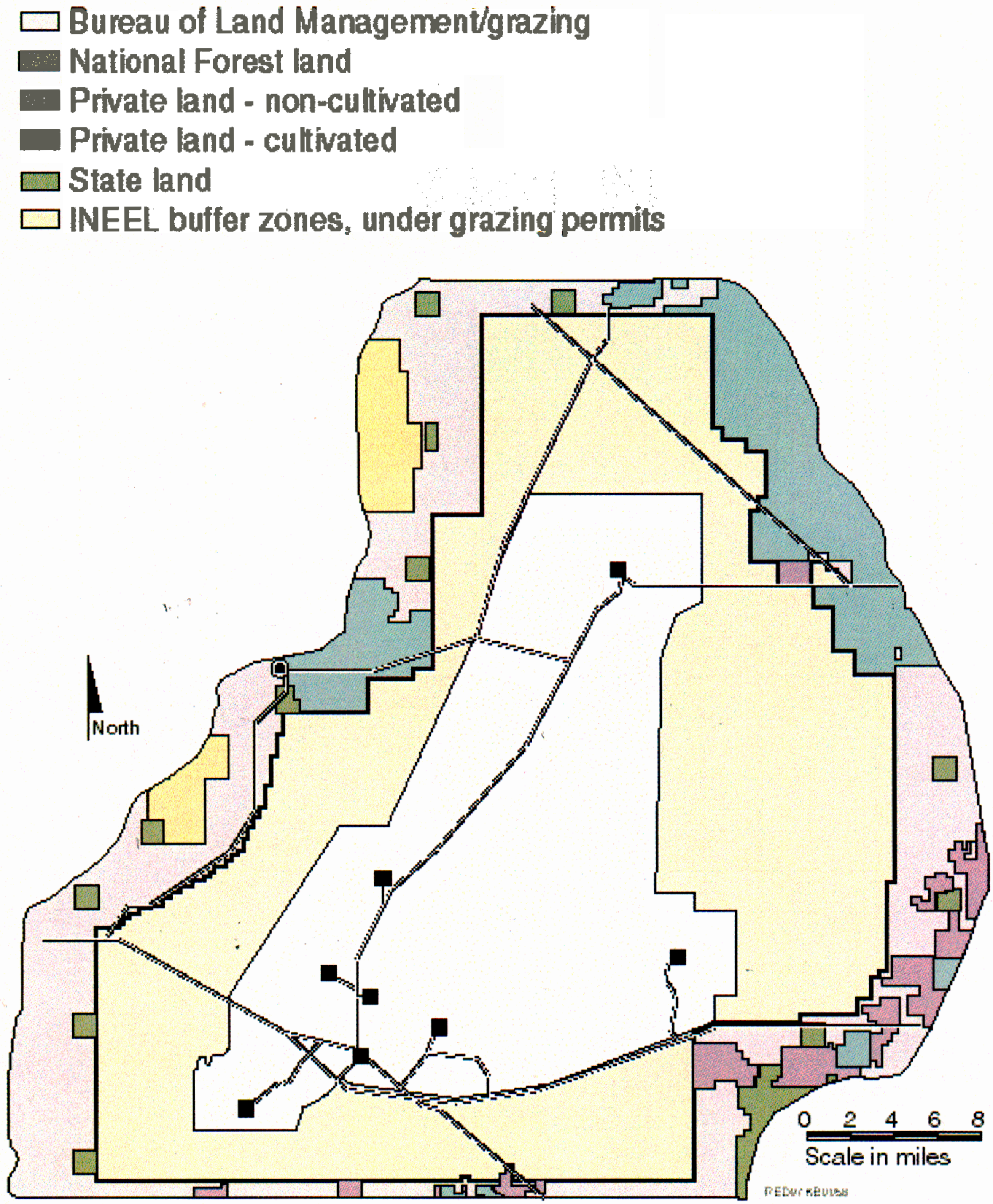

Figure 12. INEEL neighbors' lands (DOE-ID 1997).

6.2 Future Land Use

The projections for future land use at the INEEL area are influenced by the following assumptions and factors (DOE-ID 1997):

- Department of Energy projections for the future of its national laboratory research and development activities and nuclear reactor programs
- The presence of active industrial and research facilities
- The presence of an industrial infrastructure
- The likely inability to "green field" (e.g., return to natural state with unrestricted land use) the industrial complex without total removal
- The likelihood of all land use remaining industrial, with the exception of grazing by permit (it should be noted that a more conservative risk evaluation was performed assuming a current residential scenario)
- Recommendations from the INEEL Citizen's Advisory Board and other stakeholders about future use assumptions.

Land-use projections in the INEEL Comprehensive Facility Land Use Plan (DOE-ID 1997) incorporate the assumption that the INEEL will remain under government management and control for at least the next 100 years. Therefore, the baseline risk assessment (DOE-ID 2001) simulates a hypothetical residential scenario beginning in 100 years (until 2095). However, implementation of this management and control becomes increasingly uncertain over this time period. Regardless of the future use of the land now occupied by the INEEL, the federal government has an obligation to provide adequate institutional controls (i.e., limit access) to areas that pose unacceptable health or safety risks until those risks diminish to acceptable levels (see Section 12). Fulfillment of this obligation hinges on the continued viability of the federal government and on Congress appropriating sufficient funds to maintain the institutional controls for as long as necessary.

Generally, future land use within the INEEL will remain the same as current land use. Currently, the mix of land uses across the INEEL includes industrial areas, restricted and unrestricted use areas, wildlife management and conservation areas, and waste management areas. Other potential but less likely uses include agricultural applications and restoring areas to their natural undeveloped states. No residential development will be allowed within INEEL boundaries, and no new major private developments (residential or nonresidential) on public lands are expected in areas adjacent to the Site. Grazing will be allowed to continue in the buffer area. In addition, the INEEL is currently a National Environmental Research Park and is expected to remain so for the foreseeable future (DOE-ID 1997).

6.3 Groundwater Uses

The Snake River Plain Aquifer, consisting primarily of basalts and sediments and the groundwater stored in these materials, is among the nation's largest. Extending about 32 km (200 mi) through eastern Idaho and encompassing about 24,900 km^2 (9,600 m^2), the aquifer stores one to two billion acre-feet of water, which is roughly the same volume as Lake Erie. About 9% of the aquifer lies at depths ranging from 60 to 180 m (200 to 600 ft) beneath the INEEL site. The aquifer is the source of all water used at the INEEL site.

Based on a Federal Reserve Water Right, the DOE and the State of Idaho negotiated a State water right for the INEEL. The INEEL is permitted a water pumping capacity of 2.3 m^3 /sec (80 ft^3 /sec.) and a maximum water consumption of 35,000 acre feet per year. On average, though, the INEEL withdraws only 6,229 acre feet per year. About 65% of these withdrawals are eventually returned to the aquifer via percolation. Consequently, the annual consumptive usage of water withdrawn from the aquifer is about 2,200 acre feet per year (DOE-ID 1997). WAGs 6 and 10 are not major water users since all the facilities are inactive except for EBR-I, which is also inactive, but as a National Historic Landmark it is open to the public between Memorial Day and Labor Day. Most other water use by WAGs 6 and 10 is related to groundwater monitoring and other sampling events.

6.4 Groundwater Classification and Basis

All the WAG 10 sites are situated above the Snake River Plain Aquifer. The eastern portion of the aquifer was granted sole source status by the EPA on October 7, 1991 (56 FR 50634). Idaho water quality standards are identified in the Ground Water Quality Rule (IDAPA 58.01.11) and the Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02). These standards and requirements can be accessed at the Internet address "http://www.idwr.state.id.us/apa/idapa."

Three categories of protectiveness apply to the aquifer and its associated resources under Idaho regulations: (1) Sensitive Resources, (2) General Resources, and (3) Other Resources. Because no previous action to categorize the Snake River Plain Aquifer under Idaho regulations has occurred, the aquifer defaults to the "General Resources" category. General Resource aquifers are protected to ensure that groundwater quality is not jeopardized. Idaho's groundwater standards incorporate federal radiation exposure and drinking water standards (10 CFR 20, Appendix B, Table 2, and 40 CFR 141 and 143). When the two federal standards are not in agreement, the more restrictive standard applies.

7. BASELINE RISK ASSESSMENT METHODOLOGY

This section of the ROD summarizes the results of the baseline risk assessment for all sites within OU 10-04. The baseline risk assessment estimates what risks the site poses if no action is taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial actions. The methodologies implemented to evaluate the baseline human health and ecological risks are outlined below, followed by a summary of the results for individual sites within OU 10-04. Components of the risk assessment specific to the selected remedies, such as contaminants of concern, contaminant concentrations, and risk estimates, are presented in more detail in Sections 8, 9, and 10.

In conjunction with the baseline risk assessment, two broader investigations were part of OU 10-04. First, the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation contributed a summary of what is important to them in defining and remediating risks to human health and the environment. Second, OU 10-04 contains the INEEL-wide ERA. The INEEL-wide ERA evaluated risk to Sitewide ecological resources. The results of the INEEL-wide ERA and the long-term monitoring alternative components are presented in Section 11.

7.1 Native American Risk Evaluation Summary

The INEEL lies within the original territories of the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation. A wide variety of natural and cultural resources and landscape features at the INEEL directly reflect tribal cultural heritage. These resources are important to the Tribes' spiritual and cultural values and activities, oral tradition and history, mental and economic well-being, and overall quality of life. The DOE is committed to protecting not only the health and safety of the Tribes, but also the environmental and cultural resources that are essential to their subsistence and culture (DOE-ID 2001).

To enhance understanding of Shoshone-Bannock concerns, particularly those directly associated with OU 10-04, the INEEL contracted directly with the Shoshone-Bannock Tribes to obtain unique input for the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). The Tribes' report is Appendix A to the OU 10-04 Comprehensive RI/FS (DOE-ID 2001).

In the holistic worldview of the Shoshone-Bannock Tribes, the health of the land, air, water, plants, animals, and humans are paramount and interconnected. Changes and losses in the landscape are seen as leading to an imbalance in nature that affects all things. The tribes have specific concerns about contamination of land, water, and air at the INEEL. These include the maintenance of healthy populations of game and other wildlife; the continued presence of plants and animals important for traditional ritual observations; the protection of human health, particularly the health of tribal members using the INEEL under the Agreement-in-Principle, and the protection of prehistoric and traditional cultural sites and significant landscapes; the use of land in the future; and the sustainable long-term stewardship of the land and its resources.

The tribal analysis completed for OU 10-04 makes it clear that the Tribes consider all contamination at the INEEL poses a threat to the traditional subsistence and spiritual ecosystem. The OU 10-04 investigation, therefore, concluded that contaminated sites that pose unacceptable risk to human health or ecological receptors are also unacceptable from the standpoint of Shoshone-Bannock tribal concerns. The investigation further recognized that some sites would be of concern for Shoshone-Bannock interests even though the CERCLA baseline risk assessment concluded that they do not require cleanup.

The tribal report emphasizes that actions can be taken to correct changes, disturbances, and voids in the native landscape ecology, and thereby restore traditional and sustainable harmony. The cultural concerns identified in the Shoshone-Bannock evaluation were factored into the remedial investigation risk assessment and feasibility study. It is understood that remedial actions to protect human health and the environment, in conjunction with ongoing communication and consultation with the Tribes under the Agreement-in-Principle, will address some Native American concerns regarding land contamination at the INEEL.

7.2 Human Health Risk Evaluation Summary

The human health risk assessment approach used in the OU 10-04 baseline risk assessment (BRA) was based on the EPA *Risk Assessment Guidance for Superfund* (RAGS) (EPA 1989, 1992a), INEEL Track 2 guidance (DOE-ID 1994), and INEEL cumulative risk assessment guidance protocol (LMITCO 1995). The tasks associated with development of the OU 10-04 human health risk assessment included the following:

- Data evaluation
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Qualitative uncertainty analysis.

These tasks are described in the subsections below.

7.2.1 Data Evaluation

Data evaluation tasks that were completed as part of the BRA included site and contaminant screening and development of data sets for use in the risk assessment.

The site screening consisted of a review of risk assessments conducted for OU 10-04 sites identified in the FFA/CO and additional sites and OUs, which were added to WAG 6 and 10 since the first writing of the FFA/CO. As a result of the site screening, 28 of the individual sites identified in OU 10-04 were retained for quantitative risk assessment in the comprehensive BRA. The remaining sites either exhibited no risk potential (e.g., the site had no source of contamination) or a risk potential sufficiently below threshold values to preclude a significant contribution to cumulative risk. Individual sites with risk estimates greater than 1E-06 or hazard indices greater than 1.0 were retained.

Buildings and structures with a history of releases not subject to current management controls and those building and structures that possess the potential to impact cumulative risk at OU 10-04 sites were also evaluated for inclusion in the BRA. However, most WAG 6 facilities and structures have now been demolished and no longer present a hazard, and no WAG 10 facilities remain. The facility that was retained for facility assessment in the BRA was the EBR-I Reactor Facility (EBR-601/601A) and area structures, including the EBR-601 Reactor Building Annex, the EBR-602 Security Control House, and the two ANP jet engines displayed outside the EBR-I perimeter fence. The WAG 6 facility assessment sites are unique at the INEEL because they are part of a Registered National Historic Landmark to which the public has access. The risk issues for the EBR-I site and Heat Transfer Reactor Experiment (HTRE) assemblies are addressed by current management controls and are concluded to have no effect on the current or future risk calculated for the OU 10-04 CERCLA sites.

During the individual sites screening process, contaminants were eliminated after comparing detected concentrations with INEEL background concentrations (Rood, Harris, and White 1996) and with EPA 1E-06 risk-based concentrations (EPA 1995) for the most sensitive exposure pathway. Those contaminants that exceeded the screening criteria were identified as contaminants of potential concern and retained for quantitative analysis in the BRA. Potential exposure routes also were identified in conjunction with the contaminant screening.

All sampling data collected at OU 10-04 sites were evaluated to determine whether the data were appropriate and adequate for use in the BRA. This evaluation was conducted in general accordance with EPA guidance (EPA 1992a). As part of this analysis, sampling data sets were assumed to have lognormal distributions in accordance with EPA guidance on calculating concentration terms (EPA 1992a). However, true statistical distributions for the data were not determined. To calculate upper confidence limits on the means (UCLs), as recommended by EPA, sample results falling below the minimum detection limits were assigned a value of one-half the detection limit. Assigning a value of one-half the detection limit to all concentrations falling below the detection limits allowed the upper confidence limits to be calculated consistently for all of the sampling results.

Data evaluation for the UXO sites was limited by the insufficient amount of information collected during previous ground surveys. The geophysical ground surveys performed were for the most part adequate, but the areas covered by the surveys were very small compared to the areas suspected of having UXO present. This lack of information was discussed in the OU 10-04 RI/FS and will be addressed during the remedial action.

7.2.2 Exposure Assessment

An exposure assessment is a process that quantifies the receptor intake of contaminants of potential concern for those exposure pathways with a potential to cause adverse effects. The assessment consists of estimating the magnitude, frequency, duration, and exposure route of contaminants to receptors. The following exposure assessment characteristics were identified:

- Exposed populations
- Complete exposure pathways
- Contaminant concentrations at the points of exposure for the complete exposure pathways
- Intake rates
- Intake factors.

The land-use assumptions and projections discussed in Section 6 were used to identify exposure scenarios, pathways, and routes. The exposure scenarios and default soil depths evaluated in the OU 10-04 BRA are given in Table 2. The associated populations and exposure pathways are listed below and illustrated in Figures 7 and 8.

- Exposure scenarios
    - Occupational
    - Residential intrusion

Table 2. Exposure scenarios and soil depths used in the OU 10-04 baseline risk assessment.

Potentially Exposed Receptor	Land Use Scenario	Evaluated Exposure Pathways and Soil Depths
Occupational worker	Current industrial	Inhalation of volatiles (0–15 cm [0–0.5 ft])[a] Inhalation of fugitive dust (0–15 cm [0–0.5 ft])[a] Ingestion of surface soil (0–15 cm [0–0.5 ft])[a] External radiation (0–1.22 m [0–4 ft])[b]
Residential	Future residential	Inhalation of volatiles (0–3.05 m [0–10 ft])[c] Inhalation of fugitive dust (0–3.05 m [0–10 ft])[c] Ingestion of surface soil (0–3.05 m [0–10 ft])[c] Ingestion of homegrown produce (0–3.05 m [0–10 ft])[c] Ingestion of groundwater External radiation (0–3.05 m [0–10 ft])[c]
Occupational worker	Future industrial	Inhalation of volatiles (0–15 cm [0–0.5 ft])[a] Inhalation of fugitive dust (0–15 cm [0–0.5 ft])[a] Ingestion of surface soil (0–15 cm [0–0.5 ft])[a] External radiation (0–1.22 m 15 cm [0–4 ft])[b]

a. Exposure assessment considered the surface soil, defined as the top 0 to 15 cm (0 to 0.5 ft).

b. Exposure assessment considered the 0 to 1.22-m (0 to 4-ft) interval for undisturbed soil. Contamination below that depth is shielded by the topsoil.

c. Exposure assessment considered contamination within the 0 to 3.05-m (0 to 10-ft) interval because of the excavation required for a hypothetical basement.

- Exposure pathways
  - Groundwater pathway
  - Air pathway
  - Soil pathway
- Exposure routes
  - Soil ingestion
  - Inhalation of fugitive dust
  - Inhalation of volatiles
  - External radiation exposure
  - Dermal absorption from soil
  - Groundwater ingestion (residential scenario only)
  - Ingestion of homegrown produce (residential scenario only)
  - Dermal absorption of contaminants in groundwater (residential scenario only)
  - Inhalation of volatiles from indoor use of groundwater (residential scenario only).

Contaminant concentrations at the points of exposure for complete exposure pathways were based on detected concentrations as described in Section 7.2.1. If sufficient data were not available for calculating upper confidence limit concentrations, the maximum detected concentration was used. For radioactive contaminants, radioactive decay was incorporated into the intake calculations. Otherwise, no degradation mechanisms for reducing the toxicity of contaminants were considered.

Groundwater fate and transport modeling was used to predict the maximum contaminant concentrations that could occur in the aquifer from leaching and transport of nonradionuclide and radionuclide contaminants from OU 10-04. The GWSCREEN model was used to simulate the potential release of contaminants from the release sites and the transport of the contaminants through the vadose zone to the aquifer. The maximum 30-year average groundwater concentration for each contaminant of potential concern was estimated at 100 years in the future. The average concentrations at year 100 are used to calculate groundwater pathway risks for the residential exposure scenario, and the maximum average concentrations are used to calculate maximum expected groundwater risks (DOE-ID 2001).

To calculate intake rates, default intake factors from EPA guidance (EPA 1989, 1991, and 1992a) and Track 2 guidance for the INEEL (DOE-ID 1994) were used. In conjunction with conversion factors and site-specific contaminant concentrations, these values were used to calculate contaminant intakes used in the risk calculations. The specific exposure parameters used for each receptor and exposure pathway are given in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001, Appendix E). Generally, occupational scenarios simulate worker exposures for 8 hours/day, 250 days/year for 25 years and residential scenarios simulate exposures for 24 hours/day, 350 days/year, for 30 years. Standard values were used to simulate the human body (e.g., mass, skin area, inhalation rates, and soil ingestion rates).

To satisfy the objective of the OU 10-04 comprehensive risk assessment, risks produced through the air and groundwater exposure pathways were analyzed cumulatively. Cumulative risks were estimated by calculating one risk number for each contaminant of potential concern in each air and groundwater exposure route (e.g., inhalation of fugitive dust and ingestion of groundwater) for each collection of sites in close proximity to one another. Analyzing the cumulative risks for the air and groundwater pathways is necessary because contamination from all sites within an area can contribute to local air and groundwater contaminant concentrations. Conversely, individual sites within a WAG are typically isolated from one another relative to the soil pathway exposure routes (e.g., external exposure and ingestion of soil). As a result, site-specific soil pathway exposures were analyzed. Generally, however, the BRA is comprehensive because risks are evaluated from all known and potential sites within OU 10-04, and they are cumulative because risks from multiple sites are evaluated in the air and groundwater exposure pathways.

7.2.3 Conduct Toxicity Assessment

Toxicity assessment is the process of characterizing the relationship between the intake of a substance and the incidence of an adverse health effect in the exposed population. Toxicity assessments evaluate the results from studies with laboratory animals or from human epidemiological studies. These evaluations are used to extrapolate from high levels of exposure, for which adverse effects are known to occur, to low levels of environmental exposures, for which effects can be postulated. The results of these extrapolations are used to establish quantitative indicators of toxicity.

Health risks from all routes of exposure are characterized by combining the chemical intake information with numerical indicators of toxicity (i.e., slope factors for carcinogens and reference doses for noncarcinogens). The toxicity constants that were used in the OU 10-04 BRA were obtained from several sources. The primary source of information is the EPA online Integrated Risk Information System (IRIS). The IRIS database contains only those toxicity constants that have been verified by EPA work groups. The IRIS database is updated monthly and supersedes all other sources of toxicity information. If the necessary data are not available in IRIS, EPA Health Effects Assessment Summary Tables (HEAST) (EPA 1994a) are used. The toxicity constant tables are published annually and updated approximately twice per year. The HEAST contain a comprehensive listing of provisional risk assessment information that has been reviewed and accepted by individual EPA program offices, but has not had enough review to be recognized as high-quality, EPA-wide information (EPA 1994a). Summaries of the toxicity profiles for the contaminants addressed in the selected remedies to mitigate unacceptable human health risk are given below.

7.2.3.1 Lead. Lead is classified as a metal. No critical effects of lead have been reported; however, many organs and systems are adversely affected by lead exposures. The major target organs and systems are the central nervous system, the peripheral nerves, the kidneys, the gastrointestinal system, and the blood system (Sittig 1985). Anemia is one of the early manifestations of lead poisoning. Other early effects of lead poisoning can include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, digestive symptoms, abdominal pains, and decreased appetite. The major central nervous system effects can include dullness, irritability, headaches, muscular tremors, inability to coordinate voluntary muscles, and loss of memory. The most sensitive effect for adults in the general population may be hypertension (Amdur, Doull, and Klaassen 1991).

Ingestion and inhalation of lead have the same effects on the human body. Large amounts of lead can result in severe convulsions, coma, delirium, and possibly death. A high incidence of residual damage, similar to that following infections or traumatic damage or injury, is observed from sustained exposure to lead. Most of the body burden of lead is in the bone (ATSDR 1990a). Lead effects in the peripheral nervous system are primarily manifested by weakness of the exterior muscles and sensory disturbances. Lead also has been shown to adversely affect sperm and damage other parts of the male reproductive system (ATSDR 1990a). Dermal absorption of inorganic lead compounds is reported to be much less significant than absorption by inhalation or oral routes of exposure (ATSDR 1990a).

The behavioral effects of lead exposure are a major concern, particularly in children. Exposure to lead can cause damage to the central nervous system, mental retardation, and hearing impairment in children. Levels of exposure that may have little or no effect on adults can produce important biochemical alterations in growing children that may be expressed as altered neuropsychological behavior (Martin 1991).

Though an ability of lead to cause cancer in humans has not been shown, the EPA has classified lead as a probable human carcinogen through both the ingestion and inhalation routes of exposure. Lead classification is based on the available evidence of cancer from animal studies. Rats ingesting lead demonstrated statistically increased incidence of kidney tumors (ATSDR 1990a). According to some epidemiological studies, lead workers developed cancer, but the data are considered inadequate to demonstrate or refute the potential carcinogenicity of lead in humans. The EPA has not established toxicity values for lead.

7.2.3.2 RDX. RDX is a white, crystalline powder and is one of the most powerful and widely used military explosives. It can be used as base charge for detonators or as an ingredient of bursting charges and plastic explosives. RDX is a nonaromatic cyclic nitramine. RDX can be released to the environment during manufacturing or during explosive use (HSDB 2000).

The melting point of RDX ranges between 205 and 207° C. High explosives like RDX decompose by detonation. This detonation occurs almost instantaneously and is violent. The explosion may be initiated by sudden shock, high temperature or a combination of the two (Spectrum 2000).

The primary toxicity of RDX is the production of severe seizures. Status epilepticus (recurrent or continuous seizure activity lasting longer than 30 minutes in which the patient does not regain baseline mental status) has been observed following acute exposures in humans. Although the seizures produced from acute exposures seem to be completely reversible, animal data suggest that chronic exposure to doses lower than those required for seizure production may enhance the potential for other epileptogenic stimuli to produce seizures. The seizures are often accompanied by confusion, amnesia, and disorientation, and can be preceded by insomnia, restlessness, and irritability.

Other toxic effects that have been reported following exposure to RDX include changes in blood components including anemia manifested by decreased red blood cells, hemoglobin, and hematocrit. Toxic responses have also been noted in the liver, although those responses have generally not been as consistent as the convulsant responses (Lewis 2001).

The health advisory (HA) guideline for lifetime exposure is 2 ug/L (HSDB 2000). The lifetime HA is the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. Presently, there is no enforceable standard, such as an MCL for RDX.

7.2.3.3 TNT. 2,4,6-Trinitrotoluene (TNT) is a manmade, yellow crystalline solid used as a high explosive in military armaments and as a chemical intermediate in the manufacture of dyestuffs and photographic chemicals. TNT production in the United States occurs solely at military arsenals.

TNT is absorbed through the digestive tract, skin, and lungs. It is distributed primarily to the liver, kidneys, lungs, and fat, and is excreted mainly in the urine and bile (El-hawari et al. 1981). Workers involved in the production of explosives that were exposed to high concentrations of TNT in air experienced several harmful health effects, including anemia and abnormal liver function. Similar blood and liver effects, as well as spleen enlargement and other harmful effects on the immune system, have been observed in animals that ate or breathed TNT. Other effects in humans include skin irritation after prolonged skin contact and cataract development after long-term (365 days or longer) exposure. It is not known whether TNT can cause birth defects in humans. However, male animals treated with high doses of TNT have developed serious reproductive system effects. Information from occupational exposure studies suggests that TNT may cause menstrual disorders and male impotency (Zakhari and Villaume 1978; Jiang et al. 1991).

No epidemiological evidence is available showing an association between chronic TNT exposure and tumorigenicity in humans. In animal carcinogenicity studies, a significant increase in urinary bladder papillomas and carcinomas was seen in rats. TNT is classified in weight-of-evidence Group C, possible human carcinogen.

Laboratory animal studies indicate that many of the occupational epidemiological findings occur across species and from oral as well as inhalation plus dermal exposures. Laboratory studies have shown anemia in both beagle dogs and rats following oral exposures, as well as enlarged livers, and spleens, testicular atrophy and altered semen morphology.

TNT has been shown to interact with other toxic agents including ethanol, which is synergistic with TNT in producing liver disease. RDX, another high explosive that occurs frequently with TNT in environmental and workplace settings, has complex interactions with TNT and can either be additive or antagonistic depending on the effect (Lewis 2001). For the OU 10-04 evaluation the effects of TNT and RDX are assumed to be additive.

7.2.4 Risk Characterization

The characterization of risk involves combining the results of the toxicity and exposure assessments to estimate health risks. These estimates are either a comparison of exposure levels with appropriate toxicity criteria or an estimate of the lifetime cancer risk associated with a particular intake. The nature and weight of evidence supporting the risk estimate, as well as the magnitude of uncertainty surrounding the estimate, also are considered in risk assessment.

To quantify human health risks, contaminant intakes are calculated for each contaminant by way of each applicable exposure route. As discussed above, these contaminant intakes are calculated values based on measured concentration estimates. To estimate human health risks, the contaminant-specific intakes are compared to the applicable chemical-specific toxicity data. The complete results of the BRA risk characterization process, including risk estimates for each retained site and groundwater and air pathway risks for each collection of sites, are presented in the OU 10-04 Comprehensive RI/FS report (DOE-ID 2001, Appendix E). The generalized equations for calculating carcinogenic risk and noncarcinogenic hazard quotients are given below.

7.2.4.1 Carcinogenic Health Effects. The following calculations are used to obtain numerical estimates (i.e., unitless probability) of lifetime cancer risks. The risk probability is the product of the intake and the slope factor, as follows:

$$Risk = Intake \times SF \tag{1}$$

where

$Risk$ = Potential lifetime cancer risk (unitless)

$Intake$ = Chemical intake (mg/kg/day), or radionuclide intake (pCi)

SF = Slope factor, for chemicals $(mg/kg/day)^{-1}$, or radionuclides $(pCi)^{-1}$.

To develop a total risk estimate for a given site, cancer risks are summed separately across all potential carcinogens at the site, as shown in the following calculation:

$$Risk_T = \sum Risk_i \tag{2}$$

where

$Risk_T$ = Total cancer risk, expressed as a unitless probability

$Risk_i$ = Risk estimate for the i^{th} contaminant.

Similarly, risk values for each exposure route are summed to obtain the total cancer risk for each potential carcinogen.

7.2.4.2 Noncarcinogenic Effects. Health risks associated with exposure to individual noncarcinogenic compounds are evaluated by calculating hazard quotients (HQ). The HQ is the ratio of the intake rate to the reference dose, as follows:

$$HQ = Intake / RfD \tag{4}$$

where

HQ = Noncarcinogenic hazard quotient (unitless)

$Intake$ = Chemical intake (mg/kg/day)

RfD = Reference dose (mg/kg/day).

Hazard indices are calculated by summing hazard quotients for each chemical across all exposure routes. If the hazard index for any contaminant of potential concern exceeds unity, potential health effects may be a concern from exposure to the contaminant of potential concern. The hazard index is calculated using the following equation:

$$HI = \sum \frac{Intake_i}{RfD_i} \tag{5}$$

where

HI	=	Hazard index (unitless)
$Intake_i$	=	Exposure level (intake) for the i^{th} toxicant (mg/kg/day)
RfD_i	=	Reference dose for the i^{th} toxicant (mg/kg/day).

In the foregoing equation, intake and reference dose are expressed in the same units and represent the same exposure time period.

7.2.4.3 UXO Risk Characterization. Risk values based on combining toxicity and exposure could not be calculated for the ordnance areas because of the nature of the contaminant. Ordnance sites are evaluated in terms of three main components or events: UXO encounter, UXO detonation, and consequences of UXO detonation. Areas with a high potential for UXO would present a greater human health risk than areas with only a potential for UXO, and an even lower hazardous risk would apply for those areas with no known ordnance activities. A UXO encounter considers the likelihood that a person will come across UXO and will influence the UXO through some level of force, energy, motion, or other means. A UXO detonation is the likelihood that a UXO will detonate once an encounter has occurred. Consequences of UXO detonation encompass a wide range of possible outcomes or results, including bodily injury or death, health risks associated with exposure to chemical agents, and environmental degradation caused by the actual explosion and dispersal of chemicals to air, soil, surface water, and groundwater. UXO encounters are relatively uncommon, casual human contact has never caused a detonation at the INEEL.

7.2.5 Qualitative Uncertainty Analysis

The risk assessment results are very dependent on the methodologies applied to develop the risk estimates. These analysis methods were developed over a period of several years by INEEL risk management and risk assessment professionals to provide realistic, yet conservative estimates of human health risks at OU 10-04. Nonetheless, if different risk assessment methods had been used, the BRA likely would have produced different risk assessment results. To ensure that the risk estimates are conservative (i.e., generate upper-bound risk estimates), health protective assumptions that tend to bound the plausible upper limits of human health risks were applied throughout the BRA. Therefore, risk estimates that may be calculated by other risk assessment methods are not likely to be significantly higher than the estimates developed for the OU 10-04 Comprehensive RI/FS.

Uncertainty in the BRA is produced by uncertainty factors in all four stages of risk analysis (i.e., data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization). The uncertainties associated with parameters used in the risk assessment are listed in Table 3. The conservative assumptions and uncertainties in the risk estimates for the nine sites identified for remediation based on human health risk estimates in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001) are summarized in Table 4. Qualitative consideration of the collective impact of all the assumptions indicates that the risks are more likely to be overestimated than underestimated.

7.3 Ecological Risk Evaluation Summary

The WAG 6 and 10 ecological risk assessment (ERA) is a component of the phased approach developed for ERA at the INEEL. The results of the WAG 6 and 10 ERA were integrated into an INEEL-wide evaluation of potential risks to ecological receptors in the OU 10-04 RI/FS. The results and methodology of this evaluation can be found in Section 11 of this ROD. The ERA was conducted as outlined in the guidance for the INEEL (VanHorn, Hampton, and Morris 1995).

An ecological site and contaminant screening was conducted to determine which sites and contaminants would be subjected to further analysis in the OU 10-04 Comprehensive RI/FS. The screening was completed and documented as part of the Work Plan for OU 10-04 (DOE-ID 1999a). A site-by-site evaluation of the risks to ecological resources as a result of exposure to contaminants at OU 10-04 was developed in the RI/FS. The evaluation included a review of the screening completed in the Work Plan to ensure that sites or contaminants were not inappropriately omitted from further evaluation. Complete details of the ERA are presented in Appendices F and G of the OU 10-04 Comprehensive RI/FS report (DOE-ID 2001). The primary components of the ERA, discussed below, include problem formulation, analysis, risk characterization, and transition to the INEEL-wide ERA.

7.3.1 Problem Formulation

The goal of the problem formulation step is to investigate the interactions between the stressor characteristics (i.e., contaminant characteristics), the ecosystem potentially at risk, and the potential ecological effects (EPA 1992b). Site screening was conducted to identify the sites that could pose unacceptable risk. Of the 50 sites in OU 10-04, 29 were retained for quantitative evaluation in the ERA.

Contaminant screening and data evaluation were conducted to identify contaminants of potential concern and define exposure point concentrations. For the most part, the results of the data evaluation conducted for the human health BRA (see Section 7.2.1) were applied to the ERA. For those contaminants that were not retained for evaluation in the human health risk assessment, additional data evaluation to support the completion of the ERA was performed. Contaminant concentrations were compared to background concentrations and ecologically based screening levels. All radioactive contaminants were eliminated on the basis of this comparison.

Table 3. Human health baseline risk assessment uncertainty factors.

Uncertainty Factor	Effect of Uncertainty	Comment
Source term assumptions	May overestimate risk.	All contaminants are assumed completely available for transportation away from the source zone. In reality, some contaminants may be chemically or physically bound to the source zone and unavailable for transport.
Natural infiltration rate	May overestimate risk.	A conservative value of 10 cm/year was used for this parameter.
Moisture content	May overestimate or underestimate risk.	Soil moisture contents vary seasonally in the upper vadose zone and may be subject to measurement error.
Water table fluctuations	May slightly overestimate or underestimate risk.	The average value used is expected to be representative of the depth over the 30-year exposure period.
The mass of contaminants in soil was estimated by assuming a uniform contamination concentration in the source zone.	May overestimate or underestimate risk.	While not likely, most of the mass of a given contaminant at a given site may exist in a hotspot that was not detected by sampling. Such a condition could result in underestimating the mass of the contaminant used in the analysis. Assigning zero values to concentrations below detection limits also may cause mass to be underestimated. However, the 95% upper confidence limit on the mean (UCL) or the maximum detected contamination levels were used for all mass calculations. These concentrations are assumed to exist at every point in each waste site; therefore, the mass of contaminants used in the analysis is probably overestimated.
Plug flow assumption in groundwater transport	May overestimate or underestimate risk.	Plug flow models such as GWSCREEN (Rood 1994) are conservative relative to concentrations because dispersion is neglected and mass fluxes from the source to the aquifer differ only by the time delay in the unsaturated zone (the magnitude of the flux remains unchanged). For nonradiological contaminants, the plug flow assumption is conservative because dispersion is not allowed to dilute the contaminant groundwater concentrations. For radionuclides, the plug flow assumption may or may not be conservative. Based on actual travel time, the radionuclide groundwater concentrations could be overestimated or underestimated because a longer travel time allows for more decay. If the concentration decrease from the travel time delay is larger than the neglected dilution from dispersion, the model will not be conservative.
Chemical form assumptions	May overestimate or underestimate risk.	In general, the methods and inputs used in contaminant migration calculations, including assumptions about chemical forms of contaminants, were chosen to err on the protective side. All contaminant concentration and mass are assumed available for transport. This assumption results in a probable overestimate of risk.

Table 3. (continued).

Uncertainty Factor	Effect of Uncertainty	Comment
Exposure scenario assumptions	May overestimate risk.	The likelihood of future scenarios has been qualitatively evaluated as follows: Resident—improbable Industrial—credible. The likelihood of future residential development at the INEEL is small. If future residential use of this site does not occur, then the risk estimates calculated for future residents are likely to overestimate the risk associated with future use of this site.
Exposure parameter assumptions	May overestimate risk.	Assumptions about media intake, population characteristics, and exposure patterns may not characterize actual exposures.
Receptor locations	May overestimate risk.	Groundwater ingestion risks are calculated for a point at the downgradient edge of an equivalent rectangular area. The groundwater risk at this point is assumed to be the risk from groundwater ingestion at every point within WAG 6 and 10 boundaries. Changing the receptor location will affect only the risks calculated for the groundwater pathway because all other risks are site specific or assumed constant at every point within the WAG 6 and 10 boundaries.
For the groundwater pathway analysis, homogeneous distribution in a large mass of soil was assumed for all contaminants.	May overestimate or underestimate risk.	Homogeneous distribution in the soil volume beneath WAGs 6 and 10 is assumed for the total mass of each contaminant of potential concern. This assumption tends to maximize the estimated groundwater concentrations produced by the contaminant inventories because homogeneously distributed contaminants would not have to travel far to reach a groundwater well drilled anywhere within the WAG 6 or 10 boundary. However, groundwater concentrations may be underestimated for a large mass of contamination (located in a small area with a groundwater well drilled directly downgradient).
The entire inventory of each contaminant was assumed to be available for transport along each pathway.	May overestimate risk.	Only a portion of the inventory of each contaminant will be transported by each pathway.
Exposure duration	May overestimate risk.	The assumption that an individual will work or reside at a site for 25 or 30 years is conservative. Short-term exposures involve comparison to subchronic toxicity values, which are generally less restrictive than chronic values.
Conservative values were used to represent constants not dependent on contaminant properties.	May overestimate risk.	Conservative or upper-bound values were used for all parameters incorporated into intake calculations.
Some hypothetical pathways were excluded from the exposure scenarios.	May underestimate risk.	Exposure pathways are considered for each scenario and eliminated only if the pathway is either incomplete or negligible compared to other evaluated pathways.
Biotic decay was not considered.	May overestimate risk.	Biotic decay would tend to reduce contamination over time.

Table 3. (continued).

Uncertainty Factor	Effect of Uncertainty	Comment
Occupational intake value for inhalation is conservative.	May slightly overestimate risk.	Standard exposure factors for inhalation have the same value for occupational as for residential scenarios though occupational workers would not be onsite all day.
Use of cancer slope factors	May overestimate risk.	Slope factors are associated with 95% UCLs. They are considered unlikely to underestimate risk.
Toxicity values were derived primarily from animal studies for nonradioactive contaminants.	May overestimate or underestimate risk.	Extrapolation from animal to humans may induce error from differences in absorption, pharmacokinetics, target organs, enzymes, and population variability.
Toxicity values were derived primarily from high doses; however, most exposures are at low doses.	May overestimate or underestimate risk.	Linearity was assumed at low doses. The effect tends toward conservative exposure assumptions.
Toxicity values and classification of carcinogens	May overestimate or underestimate risk.	Not all values represent the same degree of certainty. All are subject to change as new evidence becomes available.
Lack of slope factors	May underestimate risk.	Contaminants of potential concern without slope factors may or may not be carcinogenic through the oral pathway.

Table 4. Summary of site-specific uncertainties and conservative assumptions for the human health baseline risk assessment.

Site	Uncertainties and Conservative Assumptions
Naval Proving Ground	This large area encompasses several (23) identified smaller areas. These areas include; CFA-633 Naval Firing Site and Downrange Area; CFA Gravel Pit; CFA Sanitary Landfill Area; Naval Ordnance Disposal Area (NODA) ; Explosive Storage Bunkers north of INTEC; National Oceanic & Atmospheric Administration site (NOAA) ; Fire Station II Zone & Range Fire Burn Area; Anaconda Power Line; Old Military Structure; Mass Detonation Area; Dairy Farm Revetments; Experimental Field Station; UXO east of TRA; Burn Ring south of Experimental Field Station; Igloo-Type Structures northwest of Experimental Field Station; Rail Car Explosion Area; UXO east of ARVFS; projectiles found near mile markers 17 and 19; Land Mine Fuze Burn Area; ordnance and dry explosives east of the Big Lost River; zone east of the Big Lost River; dirt mounds near the Experimental Field Station, NOAA, and NRF; and craters east of INTEC.
	Following the OU 10-04 Work Plan, more ordnance have been located within the Naval Proving Ground (325 square miles). Because much of the land falling within the Naval Proving Ground has not been well characterized, the possibility for detecting more UXO is high. Estimation of risk for potential UXO based on the currently known ordnance areas would underestimate the total risk.
	The boundaries for the firing fan of the Naval Proving Ground have not yet been clearly defined. The potential for undetected UXO is assumed to be over the entire area. This conservative assumption would probably lead to an overestimation of risk.
	Ground surveys used to detect potential UXO have already been carried out for a few of the smaller ordnance areas listed above; however, because of the uncertainties in the detection methods, the success of these surveys are not 100% effective. There remains a risk for additional UXO to be located in six ordnance areas where “live” ordnance is known to have been used. These areas include: NODA, NOAA, Mass Detonation Area (MDA), Experimental Field Station, Rail Car Explosion Area, and Land Mine Fuze Burn Area.
	UXO buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
	Risk values could not be calculated for this site similar to those sites with chemical or radiological contamination.
Arco High Altitude Bombing Range	No UXO has been found in this area; however, there is a potential for UXO to be located within the subsurface soil at this site. This conservative assumption could lead to an overestimation of risk.
	UXO buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
	Risk values could not be calculated for this site because the contaminant (UXO) is not a quantifiable chemical.

Table 4. (continued).

Site	Uncertainties and Conservative Assumptions
Naval Ordnance Disposal Area	The 95% UCL or maximum contaminant concentrations were assumed to exist over a large portion of the sampling . This conservative assumption would probably lead to an overestimation of risk.
	Sampling was performed at various depths throughout the area. For the risk assessment, homogeneous contaminant concentrations were assumed for the entire soil interval to the furthest sample depth taken. This assumption may overestimate the risk.
	Sampling was concentrated in the craters where the greatest amount of ordnance activity took place, which would lead to an overestimation in risk.
	Samples were taken directly from the stained soil, but TNT and RDX chunks were intentionally avoided. This would lead to an underestimation in risk at this site.
	TNT or RDX buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
National Oceanic & Atmospheric Administration	The 95% UCL or maximum contaminant concentrations were assumed to exist over a large portion of the sampling grid. This conservative assumption would probably lead to an overestimation of risk.
	Sampling was performed at various depths throughout the area. For the risk assessment, homogeneous contaminant concentrations were assumed for the entire soil interval to the furthest sample depth taken. This assumption may overestimate the risk.
	Samples were taken directly from the stained soil, but TNT and RDX chunks were intentionally avoided. This would lead to an underestimation in risk at this site.
	TNT or RDX buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
Twin Buttes Bombing Range	No UXO has been found in this area, however there is a potential for UXO to be located within the subsurface soil at this site. This conservative assumption could lead to an overestimation of risk.
	UXO buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
	Risk values could not be calculated for this site because the contaminant (UXO) is not a quantifiable chemical.

Table 4. (continued).

Site	Uncertainties and Conservative Assumptions
Fire Station II Zone & Range Fire Burn Area	The 95% UCL or maximum contaminant concentrations were assumed to exist over the entire site. This conservative assumption would probably lead to an overestimation of risk.
	Sampling was performed at various depths throughout the area. For the risk assessment, homogeneous contaminant concentrations were assumed for the entire soil interval to the furthest sample depth taken. This assumption may overestimate the risk.
	Samples were taken directly from the stained soil, but TNT and RDX chunks were intentionally avoided. This would lead to an underestimation in risk at this site.
	TNT or RDX buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
Experimental Field Station	The 95% UCL or maximum contaminant concentrations were assumed to exist over a large portion of the sampling grid. This conservative assumption would probably lead to an overestimation of risk.
	Sampling was performed at various depths throughout the area. For the risk assessment, homogeneous contaminant concentrations were assumed for the entire soil interval to the furthest sample depth taken. This assumption may overestimate the risk.
	Samples were taken directly from the stained soil, but TNT and RDX chunks were intentionally avoided. This would lead to an underestimation in risk at this site.
	TNT or RDX buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.
Land Mine Fuze Burn Area	The 95% UCL or maximum contaminant concentrations were assumed to exist over the entire site. This conservative assumption would probably lead to an overestimation of risk.
	Sampling was performed at various depths throughout the area. For the risk assessment, homogeneous contaminant concentrations were assumed for the entire soil interval to the furthest sample depth taken. This assumption may overestimate the risk.
	Samples were taken directly from the stained soil, but TNT and RDX chunks were intentionally avoided. This would lead to an underestimation in risk at this site.
	TNT or RDX buried below the surface soil may become exposed to the ground surface through erosion or frost heave, which would lead to an underestimation of risk.

Table 4. (continued).

Site	Uncertainties and Conservative Assumptions
STF-02: Security Training Facility (STF) Gun Range	The 95% UCL or maximum contaminant concentrations were assumed to exist over the entire site. This conservative assumption would probably lead to an overestimation of risk. In the absence of historical disposal data, the contaminant mass associated with the site was estimated based on source term volume and detected concentrations. This approach may result in an underestimate of risk. No risk values were calculated for this site because the maximum detected concentration for lead, 24,400 mg/kg, was well above the EPA's (1994 screening level value (400 mg/kg).

Site-specific data characterizing contaminant concentration in biota for the INEEL ERAs are sparse. Consequently, the definition of assessment and measurement endpoints (i.e., ecological receptors) is based primarily on pathway and exposure analyses. Pathway and exposure models for contaminated surface and subsurface media (see Figures 10 and 11) were combined with a food web analysis to characterize the potential risks illustrated in the ERA conceptual site model (see Figure 9).

7.3.2 Analysis

In the analysis component of the ERA, the likelihood and significance of an adverse reaction from exposure to stressors were evaluated. The exposure assessment involves relating contaminant migration to exposure pathways for ecological receptors. The behavior and fate of contaminants of potential concern in the terrestrial environment were presented in a general manner because formal fate and transport modeling was not conducted for the WAG ERA (DOE-ID 2001). The ecological effects assessment consisted of a hazard evaluation and a dose-response assessment. The hazard evaluation involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. The dose from multiple media (surface and subsurface soil) identified at WAG 6 and 10 sites was developed and used to assess the potential risk to receptors. Because dose-based toxicological criteria exist for few ecological receptors, development of appropriate toxicity reference values (TRVs) was necessary for the contaminants and functional groups at the INEEL. A semi-quantitative analysis was used, augmented by qualitative information and professional judgment as necessary.

Exposures for each functional group, threatened or endangered species, and sensitive species were estimated based on site-specific life history and, when possible, feeding habits. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate, and the fraction of diet composed of vegetation or prey and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups were derived from a combination of parameters that produced the most conservative overall exposure for the group. Parameter values and associated information sources are discussed in further detail in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001, Appendix F). The development of the TRVs for those contaminants targeted for remediation based on unacceptable ecological risks is described below.

7.3.2.1 1,3-Dinitrobenzene. 1,3-Dinitrobenzene (1,3-DNB) is one of several compounds that have been released to the environment during the manufacture of explosives and in load, assembly, and pack activities at military installations. The compound has a close structural relationship with the military explosive TNT, of which 1,3-DNB is a manufacturing by-product and an environmental degradation product.

1,3-DNB appears to be a neurological toxicant, with pronounced histopathological lesions induced in various regions of the brain as a consequence of acute dosing (Philbert et al. 1987). Numerous investigators have also studied the adverse effects of 1,3-DNB on male rat reproductive function (USEPA 1991b). These effects include Sertoli cell damage, damage to the seminiferous epithelium, reduction in late pachytene spermatocytes, decreased testicular weights, impairments in sperm morphology and motility, and reduced fertility. The lowest acute and subchronic doses associated with these effects were 15 mg/kg and 0.54 mg/kg/day, respectively. Adequate chronic data and information on effects about the female reproductive system were not available (USACE 1993). Other adverse effects associated with exposure to 1,3-DNB are decreased growth rate, weight loss, anemia, methemoglobinemia, nephropathy, and cyanosis (HSDB 2000). DNB is readily absorbed through the skin. The primary routes of metabolism involve reduction of the nitro groups and oxidation of the aromatic ring to a phenol, and data suggest that excretion is predominantly by the urinary tract (Layton et al. 1987). Results from rat studies were used to develop mammalian TRVs (Cody et al., 1981).

Due to the lack of toxicity data for birds, TRVs could not be developed for avian species. However, as reported by researchers with the U.S. Fish and Wildlife Service (Schafer, 1972; Schafer et al., 1983) LD_{50}s for RDX in Red-winged Blackbirds (*agelaius phoeniceus*) and European Starlings (*Sturnus vulgaris*) were 42 and >100 mg/kg, respectively.

7.3.2.2 Lead. Lead is a ubiquitous trace constituent in rocks, soil, plants, water, and air. Lead is neither essential nor beneficial to living organisms. For plants, the recommended screening benchmark concentration for phytotoxicity in soil for lead of 50 mg/kg was used as the TRV for terrestrial plants (Suter, Will, and Evans 1993).

In birds and mammals, lead affects the kidneys, blood, bone, and the central nervous system. Ingestion of lead shot is a significant cause of mortality among waterfowl that are partially or completely protected by law. Lead toxicity varies widely with the form and dose of administered lead. Generally, organic compounds are more toxic than inorganic compounds. For avian herbivores, a TRV was estimated using a study of mallards (Dieter and Finley 1978). The results of studies of avian insectivores (Eisler 1988), European starlings (Osborn, Eney, and Bull 1983), and American kestrels (*Falco sparverius*) (Colle et al. 1980) were used to develop TRVs for avian functional groups. Studies of rats administered lead in drinking water (Kimmel et al. 1980), lead toxicity of calves (Zmudzki et al. 1983), and lead toxicity of dogs (DeMayo et al. 1982) were used to develop TRVs for mammalian receptors.

7.3.2.3 RDX. RDX is a white, crystalline powder and is one of the most powerful and widely used military explosives. It can be used as base charge for detonators or as an ingredient of bursting charges and plastic explosives.

Data indicate there is no bioconcentration of RDX in plants, with metabolism and release to the atmosphere being the primary sources of clearance from plant tissues. In addition, there are no data to indicate biomagnification of RDX in fish and other animal tissues (ATSDR 1995).

RDX elicits similar toxic responses across a variety of species following both oral and inhalation exposures. The primary toxicity is the production of seizures following both acute and chronic exposures. Chronic exposure of rats to doses of RDX that are below the threshold to produce seizures, however, have been shown to enhance the potential for other epileptogenic stimuli to produce seizures. Other toxic effects occurring less reliably include changes in a variety of circulatory systems components. These have included anemia manifested by reduction in red blood cells, hemoglobin, and hematocrit.

Rats, mice, and dogs exposed to high single oral doses show central nervous toxicity, labored breathing and convulsions (EPA 1988a). The expression of toxicity depends on the particle size of the RDX preparation, with fine powders showing the greatest effect (Schneider et al. 1977). Based on chronic dietary studies, the rat lowest observed adverse effect level (LOAEL) (associated with prostate inflammation) was 1.5 mg/kg/day (Levine et al. 1983a) and the mouse LOAEL (associated with testicular atrophy) was 35 mg/kg/day. These doses resulted in hyperirritability, weight loss, convulsions, and severe gastrointestinal irritation (von Oettingen et al. 1949).

Rats show an increase in mortality following gestational exposure to 20 mg/kg/day (Burdette, et al., 1988) and chronic exposure to 40 mg/kg/day (Army, 1983). At 300 mg/kg/day, all rats died within 3 weeks (Levine, et al., 1990). Lethality of RDX has also been demonstrated following oral administration in other species including the mouse (80 to 500 mg/kg), cat (100 mg/kg), and rabbit (500 mg/kg). Intravenous administration has been acutely lethal in the guinea pig (25 mg/kg) and the dog (40 mg/kg) (Etnier 1989). Mammalian TRVs were developed from rat studies. However, for the lack of toxicity data avian TRVs could not be developed for birds.

7.3.2.4 TNT. 2,4,6-Trinitrotoluene is a manmade, yellow crystalline solid used as a high explosive in military armaments and as a chemical intermediate in the manufacture of dyestuffs and photographic chemicals.

TNT is absorbed through the gastrointestinal tract, skin, and lungs; is distributed primarily to the liver, kidneys, lungs, and fat, and is excreted mainly in the urine and bile (El-hawari et al. 1981). In animals, signs of acute toxicity to TNT include ataxia, tremors, and mild convulsions. Splenic hemosiderosis, leukopenia, thrombocytosis, slight hepatomegaly, and increase in kidney weight occurred in mice fed a dietary level equivalent to 700 mg TNT/kg/day for 28 days (Levine et al.1984b). Oral LD50 values of 660 to 1320 mg/kg have been reported for rats (Dilley et al. 1982).

The primary target organs for TNT toxicity in experimental animals following subchronic and chronic oral exposures are (1) liver (hepatocytomegaly and cirrhosis), (2) blood (hemolytic anemia with secondary alterations in the spleen), and (3) testes (degeneration of the germinal epithelium lining the seminiferous tubules). The LOAEL for hepatotoxicity in dogs was 0.5 mg/kg/day (Levine et al.1990a). Chronic oral toxicity studies on rats have also demonstrated TNT-induced anemia and hepatotoxicity, as well as adverse effects on the kidney (hypertrophy and nephropathy) and sternal bone marrow fibrosis (Furedi et al. 1984a). The reference dose (RfD) for chronic oral exposures, 0.0005 mg/kg/day, is based on a LOAEL of 0.5 mg/kg/day for liver effects in dogs (EPA 1991b).

Laboratory animal studies indicate that many of the occupational epidemiological findings occur across species and from oral as well as inhalation plus dermal exposures. Laboratory studies have shown anemia in both beagle dogs and rats following oral exposures, as well as enlarged livers, and spleens, testicular atrophy and altered semen morphology. Mammalian TRVs were developed from rat studies. However, for the lack of toxicity data avian TRVs could not be developed for birds.

7.3.3 Risk Characterization

Risk characterization is the final step of the WAG ERA process. The risk evaluation determines whether risk is indicated from the contaminant concentrations and the calculated dose for the INEEL functional groups, threatened or endangered species, and species of concern and considers the uncertainty inherent in the assessment. For a WAG ERA, the risk characterization step has two components: a description of the estimation of risk and a summary of the results.

Risk is estimated by comparing the calculated dose to the TRV. If the dose from the contaminant does not exceed its TRV (i.e., if the HQ is less than 1.0 for nonradiological contaminants), adverse effects to ecological receptors from exposure to that contaminant are not expected and no further evaluation of that contaminant is required. Hence, the HQ is an indicator of potential risk. Hazard quotients are calculated using the following equation:

$$HQ = \frac{Dose}{TRV} \tag{6}$$

where

HQ = Hazard quotient (unitless)

Dose = Dose from all media (mg/kg/day or pCi/g/day)

TRV = Toxicity reference value (mg/kg/day or pCi/g/day).

Hazard quotients were derived for all contaminants, functional groups, threatened or endangered species, and species of concern identified for each site of concern. The largest observed HQ across all species within WAG 6 and 10 varies by at least three orders of magnitude. When information is not available to derive a TRV, then an HQ cannot be developed for that particular contaminant and functional group or species combination.

An HQ greater than the threshold value of 1 indicates that exposure to a given contaminant, at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment, may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as the HQ values exceed the threshold value. Therefore, the HQs cannot be used to represent a probability or a percentage because an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ, the greater the concern about potential adverse effects to ecological receptors.

In general, the significance of an HQ exceeding 1 depends on the perceived "value" (i.e., ecological, social, or political) of the receptor (or species represented by that receptor), the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, order corrective action, or perform additional assessment must be determined on a site-, chemical-, and species-specific basis. With the exception of threatened or endangered species (EPA 1992b), the unit of concern in ERA is usually the population as opposed to the individual. Therefore, exceeding conservative screening criteria does not necessarily mean that significant adverse effects to populations of receptors are likely.

Seventeen sites with HQs in excess of 10 were identified in the WAG 6 and 10 ERA. As shown in Table 5, an additional screening was performed in which contaminants were eliminated from further evaluation for either of two reasons: (1) the exposure point concentration did not exceed the INEEL background concentration, or (2) the HQ was less than 10. The INEEL-wide ecological risk assessment conducted under the OU 10-04 comprehensive investigation considered the OU 10-04 sites eliminated in the additional screening: BORAX-01, BORAX-09, CPP-66, LCCDA-01, LCCDA-02, OMRE-01, CFA-633 Naval Firing Site and Downrange Area, UXO East of TRA, Burn-Ring South of Experimental Field Station, Rail Car Explosion Area, and Craters East of INTEC. Information from the INEEL-wide monitoring will be considered in the 5-year remedy reviews for WAGs 6 and 10. If indicated, additional remediation to protect ecological receptors from contamination at these sites will be considered.

Six sites, NODA, NOAA, Fire Station II Zone and Range Fire Burn Area, Experimental Field Station, Land Mine Fuze Burn Area, and STF-02, were retained for evaluation of remedial alternatives in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001) to address ecological HQs in excess of 10. Because these sites are small, it is less expensive to remediate than it is to characterize further. All six of these sites also exceed the human health risk thresholds.

UXO does not typically pose a risk to ecological receptors. Encounters ecological receptors may have with UXO are typically brief, and detonation does not occur from casual contact. It is unlikely that an animal could strike an UXO with enough force for detonation. Additionally, the loss of individual members of animal populations does not represent an unacceptable ecological risk.

Principal sources of uncertainty apply to the use of data not specifically collected for ERA and the development of the exposure assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of risk assessment parameters (e.g., plant uptake factors and bioaccumulation factors). Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. A large area of uncertainty is the inability to evaluate risk to many receptors because of the lack of appropriate toxicity data for many chemicals. This is especially a problem for certain receptors such as reptiles. In addition, because of the conservative nature of assumptions made to compensate for the lack of site-specific uptake and

Table 5. Results of OU 10-04 ecological contaminant screening against concentrations equivalent to a hazard quotient of 10.

Site	Contaminant	Maximum Concentration (mg/kg)	95% UCL (mg/kg)	INEEL Background (mg/kg)	Maximum Hazard Quotient	Comment	Considered for WAG 6 & 10 Remediation?
BORAX-01	Cadmium	6.90E+00	7.11E+00	2.20E+00	8.00E+02[a]	—	no
	Cobalt	1.52E+01	3.13E+01	1.10E+01	8.00E+00	Below background	no
	Mercury	7.00E-01	—	5.00E-02	2.00E+00	HQ < 10	no
BORAX-09	Manganese	4.97E+02	3.99E+02	4.90E+02	1.00E+01	Below background	no
	Mercury	1.20E+00	2.55E+00	5.00E-02	6.00E+00	HQ < 10	no
CPP-66	Boron	5.11E+01	9.03E+01	NA	1.00E+02[b]	—	no
	Copper	2.31E+01	2.33E+01	2.20E+01	8.00E+00	HQ < 10	no
	Strontium	1.63E+02	1.68E+02	NA	1.00E+01	HQ = 10	no
LCCDA-01	Barium	3.84E+02	3.23E+02	3.00E+02	5.00E+00	HQ < 10	no
	Cobalt	1.17E+01	1.07E+01	1.10E+01	4.00E+00	Below background	no
	Copper	2.40E+01	2.42E+01	2.20E+01	1.00E+00	HQ < 10	no
	Manganese	6.83E+02	6.36E+02	4.90E+02	1.00E+01	HQ = 10	no
LCCDA-02	Copper	2.70E+01	—	2.20E+01	1.00E+00	Below background	no
	Manganese	5.45E+02	—	4.90E+02	6.00E+00	Below background	no
OMRE-01	Chrysene	2.55E+03	—	NA	2.00E+02[c]	—	no
CFA-633	2,4,6-Trinitrotoluene	3.07E+02	6.43E+00	NA	2.00E+00	HQ < 10	no
	HMX	2.55E+01	4.18E+04	NA	4.00E+00	HQ < 10	no
	RDX	5.00E+01	6.30E+00	NA	7.00E+01[d]	—	no
NODA	1,3-Dinitrobenzene	6.00E+00	2.77E-01	NA	2.00E+00	HQ < 10	no
	Barium	4.56E+02	2.21E+02	3.00E+02	9.00E+01	Below background	no
	Cadmium	9.20E+00	2.01E+00	2.20E+00	5.00E+02	Below background	no
	Chromium	6.76E+01	3.02E+01	3.30E+01	5.00E+00	Below background	no
	Cobalt	1.71E+01	8.85E+00	1.10E+01	7.00E+01	Within the range of regional background	no
	Copper	4.86E+02	9.55E+01	2.20E+01	3.00E+01[e]	—	no
	Lead	1.79E+03	3.63E+01	1.70E+01	5.00E+00	HQ < 10	no
	Manganese	1.29E+03	3.50E+02	4.90E+02	2.00E+01	Within the range of regional background	no
	Mercury	1.90E+00	3.03E-01	5.00E-02	8.00E+00	HQ < 10	no
	Nitrate	1.10E+02	8.09E+01	NA	3.00E+00	HQ < 10	no
	Pentachlorophenol	1.00E+00	1.81E+00	NA	3.00E+00	HQ < 10	no
	RDX	**3.28E+02**	**4.88E+02**	**NA**	**4.00E+03**	—	**YES**
	Strontium	8.18E+01	6.44E+01	NA	4.00E+00	HQ < 10	no
	TPH-Diesel	1.20E+03	1.46E+04	NA	8.00E+01[f]	—	no
	Vanadium	6.07E+01	2.66E+01	4.50E+01	1.00E+01	Below background	no
	Zinc	3.62E+02	1.66E+02	1.50E+02	1.00E+01	HQ = 10	no
NOAA	**1,3-Dinitrobenzene**	**2.70E+01**	**2.26E+04**	**NA**	**2.00E+02**	—	**YES**
	1,3,5-Trinitrobenzene	7.70E+01	1.74E+11	NA	2.00E+00	HQ < 10	no
	2,4,6-Trinitrotoluene	**1.70E+04**	**8.64E+02**	**NA**	**5.00E+02**	—	**YES**
	Nitrate	4.10E+02	4.39E+02	NA	5.00E+00	HQ < 10	no
	Nitrite	1.15E+02	2.99E+02	NA	2.00E+00	HQ < 10	no
	RDX	**5.30E+01**	**1.17E+00**	**NA**	**2.00E+01**	—	**YES**

Table 5. (continued).

Site	Contaminant	Maximum Concentration (mg/kg)	95% UCL (mg/kg)	INEEL Background (mg/kg)	Maximum Hazard Quotient	Comment	Considered for WAG 6 & 10 Remediation?
Fire Station II Zone & Range Fire Burn	**2,4,6-Trinitrotoluene**	**1.30E+02**	**1.38E+03**	**NA**	**4.00E+01**	**—**	**YES**
	Copper	2.47E+01	2.42E+01	2.20E+01	3.00E+00	HQ < 10	no
	Nitrate	3.40E+02	4.49E+02	NA	5.00E+00	HQ < 10	no
	RDX	**3.70E+00**	**1.25E+06**	**NA**	**4.00E+01**	**—**	**YES**
	TPH-Diesel	1.20E+02	4.02E+03	NA	8.00E+00	HQ < 10	no
Experimental Field Station	**1,3-Dinitrobenzene**	**1.40E+01**	**1.75E+02**	**NA**	**8.00E+01**	**—**	**YES**
	1,3,5-Trinitrobenzene	8.00E+01	1.91E+03	NA	2.00E+00	HQ < 10	no
	2,4,6-Trinitotoluene	**1.10E+03**	**4.72E+05**	**NA**	**3.00E+02**	**—**	**YES**
	4-Amino-2,6-Dinitrotoluene	1.40E+01	2.60E+02	NA	2.00E+00	HQ < 10	no
	Nitrate	5.30E+02	4.06E+02	NA	4.00E+00	HQ < 10	no
	Nitrite	9.20E+01	8.14E+01	NA	1.00E+00	HQ < 10	no
UXO East of TRA	2,4,6-Trinitrotoluene	4.60E+00	2.42E+01	NA	1.00E+00	HQ < 10	no
	Nitrate	2.10E+02	2.30E+02	NA	3.00E+00	HQ < 10	no
	Nitrite	7.50E+01	6.27E+01	NA	1.00E+00	HQ < 10	no
Burn Ring South	Chromium	3.75E+01	3.89E+01	3.30E+01	7.00E+01	HQ < 10	no
	Cobalt	1.12E+01	1.11E+01	1.10E+01	5.00E+00	Within the range of background	no
	Copper	3.71E+01	3.98E+01	2.20E+01	3.00E+00	HQ < 10	no
	Nitrate	3.10E+02	3.86E+02	NA	1.00E+00	HQ < 10	no
	Zinc	2.71E+03	20.6E+08	1.50E+02	8.00E+01[g]	—	no
Rail Car Explosion	Nitrate	3.70E+02	3.46E+02	NA	5.00E+00	HQ < 10	no
	Nitrite	1.10E+02	1.16E+02	NA	2.00E+00	HQ < 10	no
	Thallium	6.90E-01	5.38E-01	4.30E-01	3.00E+00	HQ < 10	no
Land Mine Fuze Burn	**1,3-Dinitrobenzene**	**1.30E+03**	**—**	**NA**	**4.00E+03**	**—**	**YES**
	2,4-Dinitrotoluene	1.30E+03	—	NA	2.00E+02[h]	—	no
	2,4,6-Trinitrotoluene	**6.90E+04**	**1.74E+14**	**NA**	**1.00E+04**	**—**	**YES**
	Lead	1.73E+01	1.63E+01	1.70E+01	2.00E+00	Below background	no
	Nitrate	1.60E+03	3.99E+04	NA	5.00E+00	HQ < 10	no
	Selenium	2.2E+00	1.65E+00	2.20E-01	2.00E+00	HQ < 10	no
	TPH-Diesel	1.51E+02	8.29E+02	NA	5.00E+00	HQ < 10	no
	Zinc	4.46E+02	1.32E+03	1.50E+02	1.00E+01	HQ = 10	no
Craters east of ICPP	Nitrate	2.60E+02	2.65E+02	NA	4.00E+00	HQ < 10	no
	Selenium	1.20E+00	9.15E-01	2.20E-01	2.00E+00	HQ < 10	no
STF-02	Antimony	1.49E+01	1.82E+01	4.80E+00	4.00E+00	HQ < 10	no
	Copper	1.85E+02	5.42E+01	2.20E+01	1.00E+01	HQ = 10	no
	Lead	**2.44E+04**	**1.54E+05**	**1.70E+01**	**2.00E+03**	**—**	**YES**
	Manganese	5.30E+02	4.74E+02	4.90E+02	2.00E+01	Below background	no
	Zinc	4.22E+02	1.09E+02	1.50E+02	8.00E+00	Below background	no

Table 5. (continued).

Site	Contaminant	Maximum Concentration (mg/kg)	95% UCL (mg/kg)	INEEL Background (mg/kg)	Maximum Hazard Quotient	Comment	Considered for WAG 6 & 10 Remediation?

Sites BORAX-01, BORAX-09, CPP-66, LCCDA-01, LCCDA-02, OMRE-01, and the following ordnance areas (CFA-633, UXO east of TRA, Burn Ring South, Rail Car Explosion, and Craters east of ICPP) were evaluated in the INEEL-wide ecological risk assessment.

a. This COPC is found at a depth that would not pose a significant risk to the species of concern.

b. Boron was eliminated as a COPC because the only receptor with HQs greater than 10 was plants. This is a limited area and should not adversely affect the populations of plants in this area.

c. Chrysene was eliminated as a COPC because the two maximum chrysene samples, used to determine the EPCs, were associated with degraded asphalt giving an unrealistically elevated concentration for this compound (see discussion in Section 2.2 of Appendix J in the OU 10-04 Comprehensive RI/FS [DOE-ID 2001]). No significant risk is expected to occur from this COPC.

d. The risk evaluation indicates that the CFA-633 Naval Firing Site and Downrange Area have some potential for risk to ecological receptors from RDX. However, during sampling it was discovered that detected amounts of RDX were localized in smaller soil clusters, but that it is unlikely to present a widespread exposure hazard. The modeling weighted averages would have overestimated the risks for RDX. CFA-633 is highly disturbed area and does not provide desirable habitat. RDX is the only COPC at this site presenting any potential for risk. This contaminant is unlikely to pose an unacceptable risk to ecological receptors and should not be considered a risk driver at this site. These COPCs will no longer be evaluated in this ERA. However, because there is some potential for risk from exposure to RDX this COPC was further evaluated in the Site-wide ERA.

e. Four sample results for copper were removed from the data set before the exposure point concentrations (EPCs) were calculated. These samples were removed because they were representative of "hot spots." These four sample results have concentrations ranging from 24,000 to 772 mg/kg. Several other sample results showed levels above background, but they were significantly less in concentration. Therefore, risk from exposure to copper contamination at NODA Area 2 is not considered hazardous to ecological receptors. These COPCs will no longer be retained or evaluated in the FS. However, because there is some potential for risk from exposure to copper this COPC was further evaluated in the Site-wide ERA.

f. Only two ecological receptors show risk from TPH-diesel with HQs above 10 (the deer mouse and the pygmy rabbit). TPH-diesel is the only COPC, at this site, presenting any potential for risk. TPH-diesel was not further evaluated at this site (Section 12 of the OU 10-04 Comprehensive RI/FS [DOE-ID 2001]). However, because there is still some potential for risk, this COPC was retained and evaluated in the Site-wide ERA.

g. Only two ecological receptors show risk from zinc with HQs above 10, these include plants and the pygmy rabbit. Zinc is the only COPC, at this site, presenting any potential for risk. Zinc is found naturally in the environment and is present in all foods (ATSDR 1988). Zinc is likely to be strongly sorbed to soil, and relatively little land disposed zinc is expected to be in a soluble form (DOE-ID 1999). This contaminant is unlikely to pose an unacceptable risk to ecological receptors and should not be considered a risk driver at this site. Zinc will no longer be evaluated in this ERA. However, because there is still some potential for risk, this COPC was retained and evaluated in the Site-wide ERA.

h. 2,4-Dinitrotoluene (2,4 DNT) was eliminated as a risk driver at the Land Mine Fuze Burn Area because of uncertainty associated with the lab analysis. The exposure point concentration used in the ERA was based on a sample result that was considered a nondetect by the lab and by validation efforts. The high, non-detected concentrations were left in this site's data set because of the uncertainties associated with the maximum detection limit. These uncertainties limit the ability for determining risk to ecological receptors. The Land Mine Fuze Burn Area is currently being evaluated for remediation for 2,4,6-TNT contamination, and presumably this COPC will be removed as well. Post-remedial sampling will include analyzing for 1,3 DNB to determine if any residual contamination is left behind. This COPC was retained for the Site-wide ERA.

bioaccumulation factors, ecologically based screening levels for some chemicals are lower than their sample quantitation and detection limits. In the OU 10-04 analysis, this occurs for metals and a few organics. All of these uncertainties likely influence risk estimates. The major sources and effects of uncertainties in the ERA are reviewed in Table 6.

Table 6. Source and effects of uncertainties in the ecological risk assessment.

Uncertainty Factor	Effect of Uncertainty (level of magnitude)	Comments
Ingestion rates (soil, water, and food)	May overestimate or underestimate risk (moderate).	Ingestion estimates used for terrestrial receptors are based on data in the scientific literature. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally taken from Beyer, Connor, and Gerould (1994).
Acceptable hazard quotients	May overestimate or underestimate risk (high).	The magnitude of the hazard quotient indicates the level of concern for a functional group or species based on perceived importance.
Concentration factors and plant uptake factors	May overestimate or underestimate risk, and the magnitude of error cannot be quantified (high).	Few bioaccumulation factors or plant uptake factors are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, values for these parameters are obtained from Baes et al. (1984) for metals and elements, and from Travis and Arms (1988) for organics.
Toxicity reference values (TRVs)	May overestimate (high) or underestimate (moderate) risk.	To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Conservative TRVs may be below background concentrations	May overestimate (high) risk.	Because of compensation for potential uncertainties, the calculation of TRVs (see above comment) may result in risk being shown at INEEL background concentrations and give an erroneous indication of risk to certain receptors.
Lack of appropriate toxicity data to derive TRVs	Results in the inability to evaluate risk for many receptors and chemicals.	Those receptor groups and chemicals that could not be evaluated are data gaps in the assessment.
Use of functional grouping	May overestimate (moderate) risk.	Functional groups were designed as an assessment tool to ensure that the ERA address all species potentially present at a facility. A hypothetical species is developed using input values that represent the greatest exposure of the combined functional group members.
Site use factor	May overestimate (high) or underestimate (low) risk.	The site use factor is a percentage of the site of concern area compared to the home range of the receptor species. When the home range is not known for a species, a default value of 1.0 is used. This can result in an overestimate of the risk at small sites.

7.3.4 Transition to the INEEL-wide Ecological Risk Assessment

The third phase of the ERA process was the INEEL-wide ERA. The INEEL-wide ERA integrated the individual WAG ERAs to evaluate risk to Sitewide ecological resources (Section 17, DOE-ID 2001). The INEEL-wide ERA approach and results are summarized in Sections 7.5 and the long-term ecological monitoring that will be implemented under this ROD is discussed in Section 11.

The WAGs 6 and 10 sites that were retained for further evaluation in the INEEL-wide ERA included: BORAX-01, BORAX-09, CPP-66, LCCDA-01, LCCDA-02, OMRE-01, CFA-633 Naval Firing Site and Downrange Area, UXO East of TRA, Burn-Ring South of Experimental Field Station, Rail Car Explosion Area, and Craters East of INTEC (see Table 5).

7.4 Baseline Risk Assessment Summary

Unexpectedly high risks were estimated in the OU 10-04 baseline risk assessment for Ra-226 at a few sites. Further investigation revealed that reported Ra-226 concentrations were artificially high. In most cases, gamma-ray spectroscopy was the analytical method used to quantify Ra-226 concentrations. However, this method does not provide sufficient resolution to discriminate the 186-keV gamma-rays emitted by Ra-226 and U-235, both of which are naturally occurring radionuclides. Therefore, a correction factor was developed (Giles 1998a). For those sites at which the corrected Ra-226 concentrations were at or below background values, Ra-226 was eliminated as a contaminant of potential concern in soil after the baseline risks were estimated (DOE-ID 2001). The sites that were affected by the correction factor were LCCDA-01, LCCDA-02, and OMRE-01. The appropriate background values for Ra-226 are 1.2 pCi/g for analytical methods that avoid U-235 interference and 2.1 pCi/g for results that include interference from U-235 (Giles 1998b).

Risk estimates for the future residential scenario and ecological risks were used to identify sites for remediation. After the modifications to the baseline risk assessment for Ra-226, nine sites were identified for evaluation of remedial alternatives in the feasibility study: NPG (including 22 smaller ordnance sites), Arco High Altitude Bombing Range, and Twin Buttes Bombing Range for human health risks; and NODA, NOAA, Fire Station II Zone and Range Fire Burn Area, Experimental Field Station, Land Mine Fuze Burn Area, and STF-02 for both human health and ecological risks.

For remediation purposes these nine sites were grouped according to contaminated media. Three sites presented risk from explosive materials or UXO and are called the Ordnance Areas. The Ordnance Areas include the NPG, Arco High Altitude Bombing Range (ORD-01), and Twin Buttes Bombing Range (ORD-09). The site codes used to identify the ordnance areas are not presented in the FFA/CO. They were assigned to 29 individual ordnance areas identified prior to 1999 and are presented in the OU 10-04 Work Plan (DOE-ID 1999a). Many of these ordnance areas are located within the NPG. These areas include:

ORD-03: CFA-633 Naval Firing Site and Downrange Area

ORD-04: CFA Gravel Pit

ORD-05: CFA Sanitary Landfill Area

ORD-06: Naval Ordnance Disposal Area

ORD-07: Explosive Storage Bunkers- North of INTEC

ORD-08: National Oceanic & Atmospheric Administration

ORD-10: Fire Station II Zone & Range Fire Burn Area

ORD-11: Anaconda Power Line

ORD-12: Old Military Structure

ORD-13: Mass Detonation Area

ORD-14: Dairy Farm Revetments

ORD-15: Experimental Field Station

ORD-16: UXO East of TRA

ORD-17: Burn Ring South of Experimental Field Station

ORD-18: Igloo-Type Structures Northwest of Experimental Field Station

ORD-19: Rail Car Explosion Area

ORD-20: UXO East of ARVFS

ORD-22: Projectiles Found Near Mile Markers 17 and 19

ORD-24: Land Mine Fuze Burn Area

ORD-25: Ordnance & Dry Explosives East of the Big Lost River (same as the Rail Car Explosion Area)

ORD-26: Zone East of the Big Lost River ORD-27: Dirt Mounds Near the Experimental Field Station NOAA, and NRF

ORD-28: Craters East of INTEC

The second group of sites requiring remediation consists of six soil contamination sites. Five of which has TNT and/or RDX soil contamination and are called the TNT/RDX Contaminated Soil Sites. The sixth site, STF-02Gun Range, contains lead-contaminated soil. Human health risks associated with lead contamination were not calculated because approved reference doses are not available. However, the concentrations detected at STF-02 exceed the EPA 400 mg/kg screening level (EPA 1994b). The risk assessment results, for all nine sites, are described below:

- The NPG presents unacceptable risk to human health from unintentional detonation of UXO.
- The Arco High Altitude Bombing Range presents unacceptable risk to human health from unintentional detonation of UXO.
- The Twin Buttes Bombing Range presents unacceptable risk to human health from unintentional detonation of UXO.
- The NODA presents unacceptable human health and ecological risks from exposure to RDX.
- The NOAA site presents unacceptable human health risks from TNT and ecological risks from 1,3 DNB, RDX, and TNT in the surface soil.
- The Fire Station II Zone and Range Fire Burn Area presents unacceptable human health risks from TNT and potential risk to ecological receptors from exposure to RDX and TNT in the soil.
- The Experimental Field Station presents unacceptable human health risks from TNT and potential risk to ecological receptors from exposure to 1,3 DNB and TNT in the soil.
- The Land Mine Fuze Burn Area presents unacceptable human health and ecological risks from exposure to TNT.
- STF-02 Gun Range presents unacceptable human health and ecological risks from exposure to lead.

Table 7 summarizes the risk assessment results for these nine sites.

Table 7. Individual sites and contaminants of concern addressed by the selected remedy for OU 10-04.

Site	Contaminant of Concern	Exposure Pathway	Risk	Hazard Quotient
		Future Residential Exposure Scenario		
Naval Proving Ground	UXO	NA[a]	NA[a]	NA[a]
Arco High Altitude Bombing Range	UXO	NA[a]	NA[a]	NA[a]
NODA (soil)	RDX	Ingestion of groundwater	1E-02 (1 in 100)	146
	RDX	Ingestion of homegrown produce	2E-03 (2 in 1,000)	10
NOAA (soil)	TNT	Ingestion of soil	5E-05 (1 in 100,000)	7
	TNT	Ingestion of groundwater	4E-05 (1 in 100,000)	6
	TNT	Ingestion of homegrown produce	1E-03 (1 in 1,000)	200
	TNT	Dermal absorption from soil	4E-04 (4 in 10,000)	NA
Twin Buttes Bombing Range	UXO	NA[a]	NA[a]	NA[a]
Fire Station II Zone & Range Fire Burn (soil)	TNT	Ingestion of homegrown produce	6E-05[b] (6 in 600,000)	9
	TNT	Dermal absorption from soil	5E-05[b] (5 in 100,000)	NA
Experimental Field Station (soil)	TNT	Ingestion of soil	3E-06[c] (3 in 1,000,000)	NA
	TNT	Ingestion of homegrown produce	6E-05[c] (6 in 100,000)	9
	TNT	Dermal absorption from soil	2E-05[c] (2 in 100,000)	NA
Land Mine Fuze Burn (soil)	TNT	Ingestion of soil	2E-04 (2 in 10,000)	31
	TNT	Ingestion of groundwater	5E-05 (5 in 100,000)	8
	TNT	Ingestion of homegrown produce	4E-03 (4 in 1,000)	651
	TNT	Dermal absorption from soil	2E-03 (2 in 1,000)	1
STF-02 (soil)	Lead	Ingestion of soil	NA[d]	NA[d]
		Current Occupational Exposure Scenario		
Naval Proving Ground	UXO	NA[a]	NA[a]	NA[a]
Arco High Altitude Bombing Range	UXO	NA[a]	NA[a]	NA[a]
NOAA (soil)	TNT	Ingestion of soil	2E-05 (2 in 100,000)	4
	TNT	Dermal absorption from soil	2E-04 (2 in 10,000)	NA
Twin Buttes Bombing Range	UXO	NA[a]	NA[a]	NA[a]
Experimental Field Station (soil)	TNT	Ingestion of soil	6E-06 (6 in 1,000,000)	1
Land Mine Fuze Burn (soil)	TNT	Ingestion of soil	4E-04 (4 in 10,000)	70
	TNT	Dermal absorption from soil	3E-03 (3 in 1,000)	2
STF-02 (soil)	Lead	Ingestion of soil	NA[d]	NA[d]

Table 7. (continued).

Site	Contaminant of Concern	Exposure Pathway	Risk	Hazard Quotient
		Future Occupational Exposure Scenario		
Naval Proving Ground	UXO	NA[a]	NA[a]	NA[a]
Arco High Altitude Bombing Range	UXO	NA[a]	NA[a]	NA[a]
NOAA (soil)	TNT	Ingestion of soil	2E-05 (2 in 100,000)	4
	TNT	Dermal absorption from soil	2E-04 (2 in 10,000)	NA
Twin Buttes Bombing Range	UXO	NA[a]	NA[a]	NA[a]
Experimental Field Station (soil)	TNT	Ingestion of soil	6E-06 (6 in 1,000,000)	1
Land Mine Fuze Burn (soil)	TNT	Ingestion of soil	4E-04 (4 in 10,000)	70
	TNT	Dermal absorption from soil	3E-03 (3 in 1,000)	2
STF-02 (soil)	Lead	Ingestion of soil	NA[d]	NA[d]
		Ecological Exposure Scenario		
NODA (soil)	RDX	Ecological exposure	NA	≤ 1 to ≤ 4,000
NOAA (soil)	1,3 DNB	Ecological exposure	NA	≤ 1 to ≤ 200
	RDX	Ecological exposure	NA	≤ 1 to ≤ 20
	TNT	Ecological exposure	NA	≤ 1 to ≤ 500
Fire Station II Zone & Range Fire Burn (soil)	RDX	Ecological exposure	NA	≤ 1 to ≤ 40
	TNT	Ecological exposure	NA	≤ 1 to ≤ 40
Experimental Field Station (soil)	1,3 DNB	Ecological exposure	NA	≤ 1 to ≤ 80
	TNT	Ecological exposure	NA	≤ 1 to ≤ 300
Land Mine Fuze Burn (soil)	TNT	Ecological exposure	NA	≤ 1 to ≤ 10,000
STF-02 (soil)	Lead	Ecological exposure	NA	≤ 1 to ≤ 2,000

a. Human health risks cannot be calculated for unexploded ordnance in the same way that they are for chemical contamination. Instead, the need for cleanup is based on an assessment of physical danger. Unexploded ordnance poses a physical risk to human safety through the possibility of it exploding when handled or contacted, especially by machinery. Though unexploded ordnance encounters are relatively common, there has never been an accidental detonation at the INEEL caused by casual human contact (see OU 10-04 Comprehensive RI/FS Section 4.1.2 [DOE-ID 2001]).

b. The cumulative risk for TNT in Fire Station II Zone and Range Fire Burn Area is 1E-04. Therefore, TNT was identified as a contaminant of concern.

c. The cumulative risk for TNT in Experimental Field Station is 9E-05. Therefore, TNT was identified as a contaminant of concern.

d. Risks and hazard quotients were not calculated for lead for human health. Concentrations in excess of the EPA screening level of 400 mg/kg (EPA 1994b) will be remediated.

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. Such a release, or threat of release, may present an imminent and substantial endangerment to public health, welfare, or the environment.

7.5 INEEL-wide Ecological Risk Assessment Summary

The OU 10-04 INEEL-wide ecological risk assessment (ERA) was the third phase of the INEEL ERA approach. The phased approach at the INEEL evaluated the results of all WAG ERAs and other identified supporting information as inputs to the OU 10-04 ERA.

The primary purpose of the OU 10-04 ERA was to assess risk to ecological receptors at the INEEL from contamination released to the environment. This contamination is largely a result of activities performed in support of DOE and other missions, as discussed in previous RI/FS documents and this ROD. The goals of the OU 10-04 ERA are as follows:

- To evaluate and assess the sampling data collected to date including:
  - Sampling performed in 1997 and 2000 to support the OU 10-04 ERA
  - Sampling performed for the WAG-specific ERAs. Specifically, to more clearly identify sites and receptors of concern and refine the COPC list on a Site-wide basis.
- To define new assessment areas surrounding the WAGs, and to quantitatively compare the percentage of the assessment areas to species/habitat associations on the INEEL.
- To evaluate supporting information and studies previously performed on the INEEL, which qualitatively support the risk characterization.

The results of the OU 10-04 ecological assessment summarized the risk to ecological receptors Site wide. Ultimately, the risk results will be used to focus on long-term monitoring and stewardship issues.

The OU 10-04 ERA has been a multiyear effort that has included sampling and other supporting information in the form of compilations and analyses of existing data. Section 17 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001) and associated appendices H1-H12 provide detail on this effort. Similar to the individual site ERAs, the Site-wide ERA also follows the three major steps of the ERA process: problem formulation, analysis, and risk characterization (EPA 1992).

7.5.1 Problem Formulation

The activities performed in the problem formulation were highly interactive and interrelated. The problem formulation integrates available information supporting the ERA, develops the assessment endpoints and conceptual site model, and offers an analysis plan (EPA 1998). The problem formulation was a process for generating and evaluating hypotheses to determine if and why ecological effects have occurred based on site-related activities (EPA 1998).

For OU 10-04, much information was compiled, evaluated, and analyzed. The results of this effort are presented in Appendixes H-1 through H-12 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). The problem formulation analysis section summarizes the final efforts performed to support the risk assessment for the OU 10-04 ERA.

Selection of management goals, assessment endpoints, and measures for the INEEL OU 10-04 ERA constituted an important step of the problem formulation. Two elements are required to define an assessment endpoint: (1) the valued ecological entity (e.g. a species, a functional group, an ecosystem function or characteristic, a specific habitat, or a unique place) and (2), the characteristic about the entity that is important to protect and potentially at risk (e.g., reproductive viability) (EPA 1996).

The assessment endpoints for the OU 10-04 ERA can be summarized as follows:

- *De minimis* risk (defined below) to INEEL plant communities as forage base for herbivores and upper trophic level receptors
- *De minimis* risk to soil fauna communities that support plant communities and upper trophic level receptors
- *De minimis* risk to INEEL terrestrial wildlife communities, terrestrial threatened or endangered species and species of concern
- *De minimis* risk to INEEL aquatic wildlife communities, aquatic threatened or endangered species and species of concern
- *De minimis* risk to INEEL game species populations
- *De minimis* risk to the INEEL prey base.

These assessment endpoints represent components of scientific management decision points (SMDPs) (b) and (c) (EPA 1996) and reflect the general consensus of the risk assessment team. By adopting an approach similar to that presented by Suter et al. (1995), expressing endpoints in relation to *de minimis* risk offers a method for categorizing ecological risk in terms of remediation strategies. Such an approach is expected to be useful to risk managers.

De minimis ecological risk is defined as risk corresponding to the following:

- Less than 20% reduction in the abundance or production of an endpoint population within suitable habitat within a unit area.
- Loss of less than 20% of the species in an endpoint community in a unit area.
- Loss of less than 20% of the area of an endpoint community in a unit area. The term "unit area" refers to a discrete area that is at risk and may be subject to a regulatory or remedial action.

Loss of more than 20% may also be *de minimis* if the community has negligible ecological value (e.g., a baseball field) or if the loss is brief because the community is adapted to physical disturbances (e.g., the plant communities of stream gravel bars) (Suter 1995).

Due to the large size of the INEEL, the risk assessment team decided that an evaluation of the assessment areas would best represent the "measures" against which the endpoints could be assessed. Based on the WAG ERA results, attempts to measure abundance, habitat, or species loss on a landscape scale were not warranted or feasible.

The INEEL is characterized by having large inter-facility (WAG) areas that have had limited disturbance in comparison to other areas of site activities. This lack of physical or other disturbance (e.g., grazing) occurring in the areas between the WAGs has resulted in areas of the INEEL becoming an ecological treasure (Anderson 1999). Therefore, due to the impracticality and costs associated with assessing species or community abundance or production on such a large scale, it was determined that loss of 20% of habitat important to the selected species of concern would be equivalent to the *de minimis* risk definition. This assessment (or measure) is based on the refined assessment areas compared to the total INEEL habitat.

The *de minimis* risk concept has its roots in the practice of law. In law practice, the concept is applied to situations in which the item is small or irrelevant in the context of the case. The *de minimis* risk concept as applied at the INEEL is intended to identify those ecological risks that are important, and remove those that are small in the context of the INEEL. Based on the preceding discussion, endpoint populations including species of concern, game populations and prey base species are specifically protected under this approach. Protecting these endpoint species is also protective of other nonendpoint species and populations. A 20% change in individuals of a population or species within an exposure unit community is considered the limit of detection, based on variability of the numbers of each. Note that the *de minimis* approach as applied at the INEEL also considers the habitat quality of the affected sites. Most of the WAG sites are disturbed, of limited ecological habitat value, and likely support only species tolerant of human disturbance. Thus, additional species extinction within the WAG boundaries is not expected. In addition, the overall footprint of the WAGs' facility areas is minimal compared to that of the total INEEL (less than 2%).

7.5.2 Analysis

The *Guidelines for Ecological Risk Assessment* (EPA 1998) states that the analysis phase is a process to examine the primary components of risk, exposure, and effects and their relationships among each other and ecosystem characteristics. The EPA (1998) also states that the nature of the stressor influences the types of analyses conducted, and the results may range from quantitative to qualitative. As discussed in the problem formulation, the OU 10-04 ERA focuses on evaluating the contamination at the WAG sites, migration of that contamination from the WAGs, and the spatial contribution to risk. It is also critical to identify receptors and contaminants of concern at the INEEL-wide level for both assessment of risk and for future monitoring. For the OU 10-04 ERA, analysis comprised two evaluations: (1) a geographic information systems (GIS) analysis performed using interpretive maps to support the spatial evaluation (presented in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001), and (2) assessment of the WAG ERA receptors using the results of the WAG ERAs to identify species and contaminants of concern. The analysis is discussed in detail in Section 17.3 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001).

7.5.2.1 Delineation of Contaminant Spatial Extent. The extent of contamination spread from the WAGs onto the areas outside the WAG fences has been a major component of this assessment. As discussed in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001), the sizes of the WAG assessment areas were reduced based on both the air modeling (Appendix H5) and ecological sampling (Appendix H3). Original isopleths estimating the contaminated areas were compared to the sampling data, which reduced the WAG facilities' boundaries (either inside the fences or as designated by the CERCLA site mapping). Using vegetation maps and knowledge from site visits, the reduced WAG areas were assigned a vegetative class (e.g., sagebrush-steppe, grassland). Vegetation classes were assigned based on the assumption that historical vegetation communities would be present where the WAGs currently have disturbed communities.

Since detailed habitat models and data are not currently available for most species, vegetation class was used as a surrogate for general habitat features. The INEEL vegetation map (Kramber et al. 1992) was, therefore, used as the base dataset for OU 10-04 GIS analyses. A description of INEEL vegetation communities, including a vegetation map, can be found in Anderson et al. (1996).

The amount of habitat potentially adversely affected was determined by overlaying the delineation of contaminant spatial extent map onto the INEEL vegetation map and evaluating the habitat composition inside the contaminant isopleths. The results of the evaluation indicate that the overall percentage of the INEEL ecological habitats impacted by the WAG contamination is less than 2% (not including roads). The ordnance sites, assessed as part of OU 10-04, were evaluated separately due to the possible wide spread presence of these sites. The primary contaminants in the ordnance areas were TNT, RDX, and their degradation products. The overall percentage of INEEL ecological habitats impacted by known areas of TNT and RDX contamination is approximately 3%.

7.5.2.2 Analysis of Species Distribution Data at the INEEL. Distribution data sets were overlaid on the INEEL vegetation map to draw habitat associations for individual species (including mule deer, burrowing owl, ferruginous hawk, Loggerhead shrike, elk, and pygmy rabbit) and the distribution data were evaluated in relation to vegetation and contaminant isopleths to determine which receptors/resources occur in or are proximate to the areas of contamination. The results of this analysis are summarized here and detailed in Appendix H8 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). This type of observation is used to further characterize the site for future monitoring.

7.5.2.3 WAG ERA Receptor Evaluation. The results of the WAG ERAs were incorporated to develop a preliminary list of receptors for the Sitewide evaluation. All INEEL species and trophic linkages were represented in the ERAs by 36 functional groups and 14 T/E and other species of concern that were assessed individually. A summary of the WAG ERA methodology and receptors can be found in the OU 10-04 Workplan (DOE-ID 1999).

Along with expert judgment, two processes were applied to identify receptors that were evaluated in the OU 10-04 ERA: (1) Functional groups or individual species for which WAG-specific HQs exceeded 10 for any COPC at more than one WAG were retained (refer to Appendix H2) and (2) The number of COPCs for which HQs for those receptors exceeded 10 was summarized as a general indicator of spatial distribution of potential risk for functional groups and species.

The final list of WAG ERA sites and associated COPCs carried forward to the OU 10-04 ERA are discussed in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). The functional groups or individual receptors evaluated at the WAG level were evaluated in order to focus the OU 10-04 ERA on those COPCs likely to pose a risk, and those receptors most likely to be affected, Site-wide.

7.5.2.4 Analysis of the 1997 OU 10-04 ERA Sampling. Abiotic and biotic data collected in 1997 were evaluated and are discussed in detail in Appendix H3. One of the goals of the 1997 sampling event was to verify the food web modeling used for the WAG ERAs. This was accomplished by comparing a limited number of bioaccumulation factors (BAFs) calculated from Site-specific biota and co-located soil data to literature BAFs. The acronym PUF has also been used in context of the WAG ERAs to identify soil-to-plant uptake factors. The results of this evaluation indicate that for the analytes where comparisons could be made, the use of literature BAFs was sufficiently conservative, and risks associated with the dietary ingestion pathways were generally overestimated.

7.5.3 Risk Characterization

Risk characterization is the final phase of the ERA process (EPA 1998). The risk characterization clarifies the relationships between stressors, effects, and ecological entities, and uses the results of the analysis to develop an estimate of the risk. There are generally three main components of the risk characterization phase of an ERA including (1) risk estimation, (2) risk description, and (3) an uncertainty analysis.

Since the OU 10-04 ERA had a large amount of information compiled, a line of evidence approach was used to support the risk conclusions. The conclusions and recommendations section (Section 17 in the Comprehensive RI/FS [DOE-ID 2001]) summarizes the results of these efforts and discusses their implications at the OU 10-04 level. Section 17 of the Comprehensive RI/FS (DOE-ID 2001) is centered on focusing the results on assessing whether remediation efforts were warranted, but also to support the Sitewide long-term ecological monitoring and stewardship efforts that will be implemented under this ROD at the INEEL.

7.5.3.1 Risk Estimation. The risk estimation determines the likelihood of adverse effects by integrating the analysis results with the assessment endpoints (i.e., ecological receptors). The risk estimation discusses the results of the WAG ERA summaries, the spatial analysis, and the OU 10-04 ERA sampling data. The OU 10-04 ERA sampling data were also evaluated, and a sensitivity study on the Site-specific and literature uptake factors was performed to evaluate the food web modeling used in the ERA. This information is discussed in the following sections as it supported the risk assessment.

7.5.3.1.1 WAG ERA Results—Tables 17-14 through 17-24 (Section 17.3.2) in the Comprehensive RI/FS (DOE-ID 2001) present the receptors, by functional group, with hazard quotients in excess of 10 by WAG for nonradionuclides selected as OU 10-04 ERA COPCs. The nonradionuclide COPCs results at the individual WAGs and the receptors of concern potentially affected by these COPCs are similarly summarized. Radionuclides have not been of great concern for ecological receptors in the WAG ERAs and could not be evaluated using the same approach. However, they were retained as OU 10-04 COPCs due to a common presence across the INEEL.

The WAG ERA assessment developed a picture as to which functional groups and receptors were or could be potentially affected the most by the COPCs, and at which locations effects may or may not have occurred. This information allows for selecting the key receptors for long-term monitoring studies. The results of this assessment are presented in Section 17.4.1.1 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). In summary, the results of the WAG ERA indicate that multiple COPCs remain to many functional groups.

7.5.3.1.2 OU 10-04 ERA Sampling and Risk Analysis Results—The sampling and risk results for the 1997 OU 10-04 ERA sampling indicate that there is negligible potential for the spread of metals or radionuclide contamination from WAG 3 (WAG 3 was used as a worst case scenario) to the off-Site reference area. On-Site and off-Site risks were similar, and both sets of risk results were similar to or less than risks calculated for the INEEL soil background data. Uncertainty remains pertaining to the Waste Calcining facility since organics may be of concern and were not included in the 1997 sampling. Sampling and risk results for the BORAX area indicate little or no migration of radionuclides from under the engineered barrier at BORAX-02 buried reactor site.

A comparison of Site-specific uptake factors to literature values is presented in Section 17.3.3 (Table 17-25) and in Appendix H3 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). The results indicate that the use of literature values for the food web modeling is conservative and likely to overestimate potential dietary ingestion risks for several metals.

7.5.3.1.3 Spatial Analysis—The spatial analysis is presented in the analysis phase. The amount of habitat potentially adversely affected was determined by overlaying the delineation of contaminant spatial extent map onto the INEEL vegetation map and evaluating the habitat composition inside the contamination isopleths.

The results of the evaluation were discussed by WAG ERA assessment areas and by the TNT/RDX contaminated soil. The TNT/RDX contaminated soil sites were evaluated separately due to the larger area of impact and the different contaminants. These soil sites are typically less disturbed, and, therefore, provide better habitat in the area (that is, most of the WAG areas are disturbed by facility activities). The total INEEL is approximately 230,617 ha (569,865 acres), with the WAG assessment areas impacting approximately 4,317 ha (10,667 acres) or 1.87% of this total. The TNT/RDX contaminated soil sites include approximately 5,977 ha (14,769 acres) or 3% of this total. These two areas are approximately 5% of the total INEEL. The majority of the WAG and TNT/RDX contaminated soil sites are on sagebrush-steppe both on and off lava. The percentage of total area (WAG assessment areas and TNT/RDX contaminated soil sites) was compared to the selected endpoint as discussed in Appendix H6 to evaluate risk to ecological populations at the facility.

Based on the *de minimis* risk definition, risk corresponds to (1) less than 20% reduction in the abundance or production of an endpoint population within suitable habitat within a unit area, (2) loss of less than 20% of the species in an endpoint community in a unit area, or (3) loss of less than 20% of the area of an endpoint community in a unit area. Here the term "unit area" refers to a discrete area that is at risk and may be subject to a regulatory or remedial action.

The sagebrush steppe is a broad category encompassing many diverse ecological communities. Communities are defined as "populations of many species that interact," and for this assessment it was acceptable to consider the INEEL sagebrush steppe as a broad community that can be evaluated on a larger scale.

The modeled area potentially affected by the contaminants identified from the ERA sampling at the INEEL, is, therefore, less than 5% of the total area. This is significantly less than the 20% loss of area in the endpoint community accepted by the definition of *de minimis* risk (Appendix H6).

7.5.3.2 Risk Description. After risks have been estimated, risk assessors need to integrate and interpret the available information into conclusions about risks to the assessment endpoints. EPA guidance (EPA 1998) suggests that the risk characterization include evaluation of multiple lines of evidence (also referred to as a weight of evidence evaluation). Development of lines of evidence provides both a process and framework for reaching conclusions regarding confidence in the risk estimates (EPA 1998). The process includes evaluation of all available and pertinent information, even if qualitative in nature. Such sources of supporting information are used in conjunction with the quantitative risk assessment results to reach summary level conclusions and recommendations for the risk managers.

The results of the spatial estimation indicate that *de minimis* risk is produced due to contamination impact on the INEEL endpoint community. The extent of contamination is modeled to be present at significantly less than the 20% loss of total area in the endpoint community (sagebrush steppe), and it was concluded that WAG activities at the facilities have minimal impact on the ecological communities present at the INEEL. This conclusion is further supported by the information summarized in the lines of evidence table (see Table 8). The far right column provides a ranking of the overall value rating from low to high and whether the results support (+) or do not support (-) the overall risk conclusions.

The Breeding Bird Survey (BBS) and the long-term vegetation transect studies are two of the strongest supports for this conclusion. Bird populations from the state of Idaho and the nation as a whole from the past 20 years were analyzed in a similar timeframe as surveys conducted at the INEEL from 1985 to 1999. Breeding bird populations on the INEEL for the seven target species have remained constant, except for an increase in the number of mourning doves. However, this study did not assess plots near the facilities against the plots in less impacted areas at the INEEL.

The long-term vegetation transects (plots) were first established in 1950, when the area was in a severe drought. Since then, perennial grasses have increased in the plots. However, this may be seen as a step in the natural recovery from drought and overgrazing. Since the 1950s, the species richness on the plots has changed very little; however, the plant species heterogeneity has increased. Study plots outside the INEEL have produced similar results. Increases in shrub cover, perennial grasses, mean species richness, and heterogeneity have all been observed, as well as similar relative vascular plant cover. The major difference in the vegetation transects (plots) was the percentage of cover of annuals versus perennials.

An evaluation of ecologically sensitive areas identified several areas as having significant value for supporting sensitive and/or unique on-Site plant and wildlife species and communities (Reynolds 1993). The first of these areas is the area along the Big Lost River and Birch Creek. Riparian and wetland communities support a great variety of species. Buffer areas that define a reasonable area to protect these habitats have been identified (Reynolds 1993).

Table 8. Lines-of-evidence evaluation for the OU 10-04 ERA.

Item	Strengths	Weaknesses	Results	Overall Lines-of-Evidence Rating for the OU 10-04 Site-wide ERA (+/-)[a]
Ecologically Sensitive Areas overlay map (Section 17.2.4.2 [DOE-ID 2001])	Identifies areas of special concern to ecological receptors.	Characterization has significant uncertainty; much of the characterization was extrapolated.	None of the WAG facilities are directly within the buffer for protected areas. However, several of the WAGs either border or fall within sensitive biological resource areas.	Medium (+)
ERA sampling (1997) at INTEC (Appendix H3 [DOE-ID 2001])	Multi-media, radionuclides and inorganics, on-Site and off-Site, identified possible spread of contamination from WAG area, used to evaluate food web modeling assumptions.	Small sample size, no organic analyses, problem with detection limits for some analytes, not representative of the INEEL, sampling, did not include organics.	Risks for on-Site locations were less than or equal to background or the reference area; no apparent biotic uptake or movement of contamination off-Site occurring.	Low value for Site-wide characterization (+) Medium value for modeling verification (++)
ERA sampling (BORAX 2000) (Appendices C and H3 [DOE-ID 2001])	Multi-media, radionuclides and inorganics.	No off-Site data; comparison of data to earlier reference area and background data sets.	Risks for on-Site locations were less than or equal to background or the reference area; no apparent biotic uptake or movement of contamination off-Site occurring.	Low value (+)
Breeding Bird Surveys (Appendices H10 & 11 [DOE-ID 2001])	Multi year (1960s to present), nation-wide, strong and consistent methodology.	Not done every year from 1999 to present; inadequate route coverage for western U.S. limits comparisons; weather conditions can be a limiting factor during survey dates, near facility routes not compared to off facility routes.	More birds and more bird species seen/heard in 1999 than previous years back to 1985; some bird species experienced declines but these reflect state declines as well.	High value (+)

Table 8. (continued).

Item	Strengths	Weaknesses	Results	Overall Lines-of-Evidence Rating for the OU 10-04 Site-wide ERA (+/-)[a]
Long-term Vegetation Transects (Appendix H12 [DOE-ID 2001])	From 1950 to1995 with 9 samplings; core and noncore transects; consistent methodology applied.	Results prone to variance with drought and fire; study cannot be used strictly to assess grazing effects, not located in known areas of sensitive habitat.	Little evidence of directional changes other than increase in rabbitbrush and cheatgrass; results would indicate that current conditions reflect earlier heavy grazing prior to establishment of the INEEL.	High value (+)
RESL Radiological data (Appendix H4 [DOE-ID 2001])	Numerous studies; many different biota tissues sampled from around 1978 through the 80s.	Radionuclides only; may not be adequately conservative for TRA; no co-located soil data collected; data collected for research not usable for risk assessment purposes; lacks sufficient documentation on many studies; studies not directed at risk characterization, studies performed during 70s and 80s with significant remediation efforts occurring since that time.	Indicates significant radionuclides present in biota in the past; however, of limited value since conclusive results can not be obtained from different studies over many years by different researchers.	Low value (-)
Warm Waste Ponds Air Dispersion Modeling (Appendix H5 [DOE-ID 2001])	Worst case scenario for conservatism, EPA-approved methodology; supported further delineation and reduction in size of the assessment areas.	Limited inorganic data – only chromium evaluated along with Cs-137, Co-60, and Sr-90.	Off-Site radiological and inorganic contamination due to wind dispersion is unlikely; supported reduction of the WAG areas for assessment of *de minimis* risk.	Medium value (+)

Table 8. (continued).

Item	Strengths	Weaknesses	Results	Overall Lines-of-Evidence Rating for the OU 10-04 Site-wide ERA (+/-)[a]
WAG Biological Surveys (1997-99) (Appendix H7 [DOE-ID 2001])	The surveys were performed by the Environmental Science and Research Foundation and findings for WAGs 1, 2, 3, 4, 5, 6, 7, 9, and 10 have been documented in a draft report included in Appendix H7.	WAG 8 not included; qualitative, not quantitative; limited effort and does not provide a thorough T/E survey; will need to be updated to support CERCLA 5-year reviews and long-term stewardship issues.	Identified habitat present at WAGs; was used primarily for supporting the WAG ERAs; is presented here since it documents the final.	Medium value (+/-)
WAG ERA Summaries (Appendices H1 & H2 [DOE-ID 2001])	Allows rollup to INEEL-wide ERA, identifies receptors at greatest risk from WAG contaminants and the COPCs contributing to these risks.	Problems with some of the ERA results and other methodology inconsistencies; WAG 7 not assessed; characterization at WAGs may be adequate, but this information is difficult at this level to evaluate.	Identified receptors and COPCs for long-term monitoring and risk characterization.	High (-)

a. + Indicates positively supports the overall risk conclusions, - indicates that results do not support the overall risk conclusions.

Four TNT/RDX contaminated soil sites that were evaluated in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001): NODA, NOAA, Land Mine Fuze Burn Area, and the Fire Station border the Big Lost River or are within the buffering area of the Big Lost River. RDX and TNT chunks, fuzes (primers), frag (metal fragments), and projectiles were found in these areas. Shrapnel and frag are common to all of the sites, and are found on both sides of the river and in the river itself, which was dry during the walkdowns. Pronghorn, mule deer, elk, raptors, and small mammals were all observed in these areas during the summer of 2000. No sage grouse leks were observed in the ordnance areas stated above. Much of the area that served as a firing range in the 1950s was not surveyed in the field walkdowns in the summer of 2000. A significant portion of the buffer areas, sage grouse leks, pronghorn wintering area, and sensitive biological resource areas fall within the footprint of the firing area.

None of the WAG facilities are directly within the buffer for protected areas. However, several of the WAGs either border or fall within sensitive biological resource areas (e.g., WAG 1) because the facilities are so close to these sensitive biological resources areas and much of the firing area has not been surveyed.

The WAG Biological Surveys identified habitat for sensitive species at the WAG sites. Although limited in scope, the effort supported the WAGs during their RI/FS process and can be used to help focus future monitoring at those WAGs that have superior habitat characteristics. These surveys identified some areas on the WAGs that have significant habitat for sensitive species. The results neither support nor negate the risk conclusions. However, this was not a formal threatened or endangered (T/E) survey, and did not include species of concern recently identified, such as the sage grouse.

Some of the Radiological and Environmental Sciences Laboratory (RESL) data collected during various studies from the 1970s to 1980s was summarized. These RESL studies focused on radionuclides, collected for research, and were not generally useful for risk assessment purposes, and did not support transport from soil to biota calculations (no co-located soils). It is apparent that many of the sites that contributed significant risk in the studies have since been remediated. This information, therefore, is of limited value.

Results from the individual WAG ERAs were used extensively in the assessment to identify the receptors and contaminants of concern Site-wide. From the air dispersion modeling and the ERA sampling at INTEC, it was concluded that contamination is limited to small areas within the WAG boundaries. These areas represent limited ecological habitat relative to the INEEL as a whole. On the other hand, the results showed that there were low to significantly high unacceptable risks to several ecological receptors at the WAGs due primarily to metals and explosives.

The 1997 and 2000 ecological sampling activities provided a degree of certainty to the risk conclusions. The limitations of these results were due primarily to the low number of on-Site samples collected, which were located in one small area (CPP plume) relative to the large expanse of the INEEL. To a lesser degree was the lack of organic analytical results. The BAFs (and PUFs), which were calculated for several metals from the 1997 biota and co-located soil data, provide a relatively strong degree of confidence that the use of the literature-derived uptake factors were appropriately conservative. As a result, it is likely that potential risks associated with the dietary ingestion pathway are protective of ecological receptors. The 1997 results also support the premise that WAG contamination has not spread off the INEEL and the reduction of the assessment areas. The reduction in assessment areas is also supported by the Warm Waste Pond Air Dispersion Modeling.

7.5.4 Uncertainty Analysis

The ERA uncertainty analysis identifies, and to the extent possible, quantifies the uncertainty in problem formulation, analysis, and risk characterization (EPA 1992). The uncertainties from each of these phases of the process are carried through as part of the total uncertainty of the risk assessment. The product of the uncertainty analysis is an evaluation of the impact of the uncertainties on the overall assessment and, when feasible, a description of the ways in which uncertainty could be reduced. The basic categories include the following:

- Uncertainty in the CSM, TRVs, and exposure parameters
- Assessment area/habitat assessment uncertainty
- Uncertainty in the summary of WAG ERAs
- Uncertainty in the ERA sampling and analysis
- Uncertainty associated with the other lines of evidence (i.e., supporting information).

Uncertainty in the ERA process may be addressed both qualitatively and quantitatively. There are two general approaches to tracking uncertainty quantitatively. The first is to develop point estimates for each exposure parameter and toxicity value, and to obtain a point estimate for the HQ and HI. By using different sets of exposure parameters (i.e., average [or central tendency] or conservative [reasonable maximum exposure (RME)]) and toxicity values (i.e., NOAEL and LOAEL), the bounds of uncertainty of the risk estimates can be defined. The second approach is to perform a distributional analysis so that a distribution of the risks can be obtained.

For the WAG ERAs and the OU 10-04 ERA, risk estimates were obtained using a modified RME exposure scenario. The maximum or 95% UCL, whichever was lower, and mean ingestion rates and body weights (BW) were typically used. This approach was meant to be conservative. With the exception of the ecological remediation goal evaluation for lead (Appendix K, DOE-ID 2001), a distributional analysis (such as a Monte Carlo analysis) was deemed unnecessary for the WAG 6 and 10 site ERAs at the INEEL due to the low risks observed. As a result, the uncertainties in the ERA process will be discussed qualitatively.

The number and types of samples taken in support of the ERA were frequently restricted. It was often not possible to obtain as many samples as the DQOs suggest. As a result, extrapolations were made based on fewer samples and analytes, a process that can introduce considerable uncertainty. It is also possible, due to the limited number of samples and analytes, to entirely miss the contamination. Uncertainty also arises in the selection of various sampling depths. Often, the selection relies heavily on visual observation and professional judgment. The actual collection depths may vary from those planned due to obstructions, cobble, or lack of adequate soil materials.

7.5.4.1 Overall Uncertainty and Assumptions. Although there are many sources of uncertainty attributed to the ERA process, only the major issues have been included in this discussion. The risk assessment results indicate that contamination is not widespread and that the majority of INEEL receptors were adequately evaluated. Although extensive monitoring of radionuclides has occurred off the facilities by Environmental Monitoring, RESL, and the off-Site surveillance program, organics and metals are not well characterized. These contaminants may have a greater impact on ecological receptors than the radionuclides.

Several assumptions were associated with the INEEL-wide ERA. It assumed that contamination and associated effects from past activities at the WAGs were mostly confined within the WAG fence lines based on evidence from ERA sampling and air modeling. It also assumed that recent CERCLA cleanup activities have removed, will remove, and/or will stabilize most of the contamination within the WAG sites that will eliminate the possible exposures that have been detected by past radiological biotic studies. It was also assumed that no sensitive species were present at the site and that a population model would be adequate for the assessment.

An ecological risk assessment usually requires consideration of many more factors than does a human health risk assessment. For example, more than 200 species of plants and animals can be found on the INEEL, either part, or all, of the year. These species interact in numerous and complex ways, such as predation, plant eating, and scavenging, which must be taken into account. As well, the ecological risk assessment must take into account wide variations in ranges including migration patterns, and must account for the tendency for many contaminants to accumulate as they move up the food chain. Finally, habitat requirement, life cycle, or tolerance to the range of contaminants released, the EPA is subject to a number of areas of uncertainty. These uncertainties were identified by the Agencies in 1997 through 1999 as part of the INEEL-wide ERA planning process. Uncertainty issues relevant to the INEEL-wide ERA are presented in Section 17 and Appendix F of the Comprehensive RI/FS (DOE-ID 2001).

7.5.5 Other INEEL Specific Issues

The INEEL is considered an ecological treasure (Anderson 1999). A special benefit of the site being set aside for government use was the protection of what is arguably the largest expanse of protected sagebrush-steppe habitat anywhere in the United States. Approximately 40% of the INEEL has not been grazed for the past 45 years. Recognizing the importance of this undisturbed area as an ecological field laboratory, the area was also designated as a National Environmental Research Park (NERP) in 1975. This is one of only two such parks in the United States that allows comparative ecological studies in sagebrush-steppe ecosystems (DOE-ID 1997).

July 17, 1999, the Sagebrush-Steppe Ecosystem Reserve was created at the INEEL. This reserve will conserve 74,000 acres of unique habitat on the northwest portion of the INEEL. The INEEL contains some of the last sagebrush-steppe ecosystem in the United States. This action recognized that the INEEL has been a largely protected and secure facility for 50 years and that portions are valuable for maintaining this endangered ecosystem.

The U.S. Geological Survey (USGS) evaluated endangered ecosystems of the United States (Noss et al. 1995). In this study both the ungrazed sagebrush-steppe in the Intermountain West, and the Basin big sagebrush (*Artemisia tridentata*) in the Snake River Plain of Idaho are listed as ecosystems that are critically endangered (>98% decline).

Several wildlife species are found only or primarily in sagebrush habitats throughout their range. About 100 bird, 70 mammal, and 23 amphibian and reptile species in the Great Basin rely to some degree on sagebrush habitat for shelter and food. Some are sagebrush obligates—sagebrush lizard, pygmy rabbit, pronghorn, sage sparrow, brewer's sparrow, sage grouse, loggerhead shrike, and sagebrush vole, which cannot survive without plenty of high-quality sagebrush and its associated perennial grasses and forbs. Other species depend on sagebrush for a significant portion of their diet. For example, pronghorn depend on sagebrush for nearly 90 percent of their diet (Lipske 2000).

A 1999 report prepared by the Western Working Group of the International Bird Conservation Coalition Partners in Flight warns that more than 50 percent of shrubland and grassland bird species in the Intermountain West show downward population trends. Sage grouse numbers have dipped more than 33 percent in the last 15 years, according to BLM studies. As these species come increasingly to the attention of the concerned public, it will be critical to have the information to support the decisions made for the assessment.

Other current risks to the sagebrush steppe include invasion of both exotic weeds and juniper, subdivision of private lands, improper livestock grazing, and impediments to management practices caused by litigation. The major current risk to maintaining productivity of these communities is the invasion of exotic species across the entire ecoregion and juniper encroachment where native juniper woodlands occur in conjunction with the sagebrush-steppe. In some cases, exotic species may invade undisturbed communities (without grazing or fire), and in other cases, improper livestock grazing and wild or prescribed fire provide disturbances that open communities to invasion. Exotic weed invasion is not clearly understood at this time and management practices are not adequate to prevent such invasion.

7.5.6 Conclusions and Recommendations

Investigations determined that more than 100 contaminated sites at different individual WAGs on the INEEL pose risk to ecological receptors. These 100 sites were evaluated in the INEEL-wide ERA. Of those 100 sites, 68 had hazard quotients greater than 10 and required further evaluation. At 28 of the 68 sites, remediation is in progress or has been completed. An additional six sites (the five TNT/RDX Contamination Sites and the STF-02 Gun Range, described in this ROD) were evaluated in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001). Naval Reactors Facility (NRF) (WAG 8) sites were included only qualitatively in the INEEL-wide ERA because of the different risk assessment methodology used at NRF. Also, because investigations are not complete for the Radioactive Waste Management Complex (RWMC) (WAG 7) and the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm (OU 3-14), information from these areas could not be included in the INEEL-wide ERA.

The following conclusions were drawn as a result of the INEEL-wide ERA concerning the risk to ecological receptors from release sites at the INEEL:

- The contamination from past activities at the WAGs is fairly confined to the WAGs, based on evidence from ERA sampling and air modeling.
- Recent CERCLA cleanup activities have removed or will remove and/or stabilize most of contamination within the WAG sites.
- Impact is limited to a small percentage of overall area (i.e., of total INEEL area) that has been adversely affected by these activities.
- The presence of large areas of undisturbed vegetation has benefited the receptors at the Site, primarily the result of reduced grazing.

The evaluation of the assessment area to habitat area was used as a measure for the assessment endpoints. From this analysis, it is evident that less than 20% of the habitats present on the INEEL are lost to facility activities. Therefore, the overall results indicate that there is *de minimis* risk to the INEEL plant communities, terrestrial wildlife communities, species of concern, soil fauna, game species, and prey base. Multiple lines of evidence, as presented in Table 8, support the results of this analysis.

The assessment used a population level approach for the evaluation of the receptors at the INEEL, with the assumption that much of our modeling and other characterization has been adequate for evaluating this large facility area. The policy has been to pass the WAG ERA results to the OU 10-04 ERA with the understanding that for populations at the INEEL, in the larger perspective, the risk is minimal. The WAG ERA results indicated that potential risk at the individual WAGs may remain but is not a risk to the population.

The population level assessment would be invalidated if a species on the INEEL obtained federal T/E listing (e.g., the sage grouse is currently under consideration).

The results of the WAG ERAs identified that COPCs contributing to risk and the receptors at greatest exposure is presented in Section 17.4.1 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001).

For WAG 6 and 10 sites, the ERA results identified secondary explosives at many sites represented the greatest risks to ecological receptors. If these items and contaminated soil were left in place, the risks would be due primarily to ingestion of RDX, TNT, and other explosive degradation products. It is uncertain as to whether these materials would be mistakenly ingested as food items by mammalian and avian receptors, but some potential remains for this exposure pathway, especially during preening and grooming activities. Small mammals and ground feeding birds were identified as the most likely receptors to be exposed. Risks associated with accidental detonation of UXO are expected to be minimal.

The WAG ERA summaries were used to identify receptors for evaluation of risk in the OU 10-04 ERA. However, based on the WAG ERAs, some apparent risk to receptors at the sites may be possible and concerns to ecological receptors were identified. However, assessment of the effects to ecological receptors due to low levels (minimal risk) of contaminants over long periods of time is difficult. Loss of habitat off and on-Site from new facilities/activities could potentially impact populations on the Site. Off-Site contamination from surrounding farming activities were also identified as a concern.